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A Brief Description of 'Inqalab Mung' Mungbean (*Vigna radiata* L. Wilczek) Variety Released for the Agro-Climatic Conditions of Khyber Pakhtunkhwa, Pakistan

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Abstract. 'Inqalab Mung' (DM-3) was developed through cross between VC1482 C and NM-92 at Agricultural Research Institute, Dera Ismail Khan, Pakistan. Various experiments for production technology and yield performance of Inqalab Mung were conducted from 2005 to 2008 in different seasons and locations. Result showed that 40 kg/ha seed rate with 30 cm row spacing, fertilizer dose @ 20:50 kg/ha $N:P_2O_5$ and inoculation with rhizobium strain Vm M1 were optimal for its maximum yield. Inqalab Mung outclassed among all candidate lines included in NUYT-2007 and 2008 with average yields of 961.5 kg/ha and the highest grain yield of 3620 kg/ha. Inqalab Mung has 28-36% high grain yield potential compared to the standard variety NM 98 and parent NM 92 along with resistance to charcoal rot, cercospora leaf spot and yellow mosaic virus (YMV). Provincial Seed Council (PSC), Khyber Pakhtunkhwa, approved DM-3 as 'Inqalab Mung' for general cultivation in KPK in 2014.

Keywords: mungbean (*Vigna radiata* L. Wilczek), Inqalab Mung, grain yield, bold seeded

Introduction

Mungbean (*Vigna radiata* L. Wilczek), is an indigenous legume and one of the most important pulse crops. Mungbean is rich in digestible proteins (24%) and utilized in the cereal-based diets (Khattak *et al*., 2006). It contains vitamin A (94 mg), iron (7.3 mg), zinc (3 mg), calcium (124 mg) and folate (549 mg) per 100 g dry seed. Usually it is used in split form (Dhal) and in other different food products (Rasul *et al*., 2012). Fallow period window of 70-90 days during April to June in rice wheat cropping system is very suitable to plant mungbean. Mungbean is low input requiring, short duration, high value and restorative crop (Achakzai *et al*., 2012). Being leguminous crop it fixes nitrogen thereby improving soil fertility (Khan *et al*., 2008). Fitting mungbean in cereal cropping system can increase farmers' income, improve soil productivity and saving irrigational water (Hussain *et al*., 2012). Mungbean cultivars so far release in Pakistan have comparatively longer growth duration (90-110 days), indeterminate growth habit (Jahan and Golam, 2012), low yielding (400 kg/ha), small seed, susceptible to yellow mosaic virus (YMV) and insects (Rehman *et al*., 2009). Developing cultivars having short growth duration (55 to 65 days), high yield potential (up to 2000 kg/ha), synchronized maturity, resistance to MYMV, Cercospora leaf spot and having bold seeds (Aslam *et al*., 2010). Agricultural Research Institute, Dera Ismail Khan released 'Inqalab Mung' a variety developed from cross between AVRDC line and NM-92, that gives better yield (up to 2.5 t/ha) and is early maturing, bold seeded and having resistant against Mungbean Yellow Mosac Virus (MYMV) disease. The variety has been recommended for general cultivation in both spring and summer seasons in KPK province. It is the first ever variety approved for general cultivation in both seasons. Moreover, it has got full adaptability to recent climate changes prevailing in the area.

The present study therefore, presents the detailed developmental and evolution process of this new high yielding bold seeded mungbean variety.

Materials and Methods

AVRDC genotype VC 1482C having high yield potential but un-acclimatized to the agro-climatic conditions of Pakistan (highly susceptible to MYMV) was crossed with NM-92 (local mungbean cv.) having high resistant to MYMV adopting breeding procedures of Khattak *et al*. (2003b). F_1 generation of the cross was planted during summer (May-July) 1999 and the recombinants were harvested individually. F_2-F_5 generations were raised as plant to row progenies for selecting high

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yielding recombinants having resistance to MYMV during kharif 1999 to 2003. Kabuli Mung, a highly susceptible MYMV line was used as spreader and planted after each five rows to intensify MYMV disease. MYMV disease rating (0-9) was done as per method used by Sadiq *et al*. (2006). After getting enough seed, the line was tested in preliminary yield trial (PYT) at institute to check the performance of promising line with improved check varieties. Replicated yield trials major varietal trial (MVT) and advance yield trial (AYT) were conducted using randomized complete block design (RCBD) with plant-to-plant (10 cm), row-to-row spacing (30 cm), number of rows (6) and row length (4 m) (Ahmad *et al*., 2004). The trials data were analysed according to Steel and Torrie (1980).

Results and Discussion

Yield performance. ***Preliminary yield trial.*** Twenty one lines were evaluated in PYT during 2005. Inqalab Mung (DM-3) gave better yield (1130 kg/ha) against check variety NM-92 (1038 kg/ha) (Table 1).

Major yield trial (MYT). In MYT, Inqalab Mung (DM-3) out yielded all other lines including check with grain yield 1273 kg/ha (Table 2).

Advance yield trial (AYT). In AYT, Inqalab Mung (DM-3) again gave highest yield (1056 kg/ha) in the trial (Table 3).

National uniform yield trial in 2007 and 2008. In mungbean NUYT conducted during 2007, candidate variety Inqalab Mung (DM-3) was tested at fifteen locations all over the country and gave best yield as compared to both check varieties NM-06 and NM-92. Similarly in NYUT-2008, candidate variety (DM-3) was tested at thirteen locations and it performed better than check variety NM-06 (Table 4-6).

Disease resistance. The candidate variety Inqalab Mung (DM-3) was tested at CDRI, NARC, Islamabad for disease reaction, it was found resistant to most common diseases in Pakistan i.e. charcoal rot, bacterial leaf spot and leaf crinkle virus while moderately resistant yellow mosaic virus (Idahosa *et al*., 2010) (Table 7).

Table 1. Performance of DM-3 (Inqalab Mung) in preliminary yield trial-2005 (spring)

Entries	Plant height (cm)	Days to 50% flowering	Day to 90% maturity	No. of pods/plant	1000 grain weight (g)	Grain yield (kg/ha)
DM1	58.33 efg	42.33 ij	86.67 gh	59.00 hi	40.00 i	726.7 ij
DM2	64.33 bc	43.33 hi	87.33 g	80.67 c	50.33 bc	949 bcd
DM3	55.00 hij	43.00 hij	84.33 h	97.00 a	52.33 a	1130 a
DM4	53.33 ijkl	42.00 j	88.33 efg	70.00 de	47.00 d	850 efg
DM5	54.00 ijk	45.67 fg	90.00 def	54.00 kl	39.00 i	662.7 jk
DM6	64.33 bc	50.00 a	94.33 a	60.67 ghi	42.00 h	746 hij
DM7	50.67 l	48.00 bc	91.67 bcd	68.33 de	46.33 de	850.3 efg
DM8	69.33 a	47.00 cde	91.33 bcd	66.67 ef	45.00 ef	841.3 efg
DM9	52.00 jkl	46.33 efg	91.00 cd	63.67 fg	44.33 fg	780.7 f-i
DM10	61.00 de	47.00 cde	91.67 bcd	80.00 c	49.00 c	905 cde
DM11	67.00 ab	48.00 b	92.67 abc	70.33 de	47.00 d	863.7 def
DM12	57.33 fgh	50.67 a	93.67 ab	55.00 jkl	42.00 h	735 hij
DM13	64.67 bc	44.00 h	88.33 efg	52.00 l	39.67 i	600 k
DM14	60.33 ef	42.33 ij	87.33 g	54.33 kl	40.00 i	601.3k
DM15	52.00 jkl	43.33 hi	87.33 g	57.33 ijk	41.67 h	772 ghi
DM16	63.67 cd	43.00 hij	87.67 fg	71.67 d	49.00 c	864 def
DM17	56.33 ghi	47.67 bcd	90.00 def	62.33 gh	43.00 gh	791.7 f-i
DM18	51.00 kl	48.00 bc	90.33 cde	63.67 fg	44.67 f	820.7 e-h
DM19	60.67 de	46.67 def	90.67 cde	58.33 ij	42.00 h	720.3 ij
NM-98	58.33 efg	45.33 g	91.67 bcd	81.67 c	51.00 ab	976.7 bc
NM-92	59.00 efg	47.67 bcd	94.66 a	87.33 b	50.67 b	1038 b
CV	3.21	1.71	1.62	3.41	2.21	6.75%

Table 2. Performance of DM-3 (Inqalab Mung) in major yield trial-2005 (Kharif)

Entries	Plant height (cm)	Days to 50% flowering	Day to 90% maturity	No. of pods/plant	1000 grain weight (g)	Grain yield (kg/ha)
DM2	65.67 a	44.33 ab	87.67a	80.33 b	50.00 b	1086 bc
DM3	56.00 c	43.67 ab	84.33 b	88.00 a	53.67 a	1273 a
DM4	55.00 c	46.33ab	88.00 a	75.67 c	48.33 b	1044 c
DM7	53.33 c	45.67 a	88.33 a	72.00 d	46.33 c	918.3 d
DM10	61.33 b	43.00 ab	87.67 a	65.33 e	46.33 c	795.3 e
DM11	66.67 a	44.33 b	87.00 ab	67.67 e	45.00 c	836 de
DM-16	64.67 a	44.00 ab	88.65 a	58.00 f	45.67 c	670.3 f
NM-98	60.35 b	44.00 ab	89.00 a	81.00 b	49.67 b	1107 bc
NM-92	61.33 b	43.67 ab	89.66 a	87.33 a	50.00 b	1173 b
CV	2.79 %	4.07 %	2.18 %	2.24 %	2.27 %	5.59 %

Table 3. Performance of DM-3 (Inqalab Mung) in advanced yield trial-2006

Entries	Plant height (cm)	Days to 50% flowering	Day to 90% maturity	No. of pods/plant	1000 grain weight (g)	Grain yield (kg/ha)
DM2	65.67 a	43.67 NS	84.33 b	88.00 a	53.67 a	1051 a
DM3	56.00 c	44.33	87.67 ab	80.33 b	50.00 b	1056 a
DM4	55.00 c	46.33	88.00 ab	75.67 c	48.33 bc	707 b
DM7	53.33 c	45.67	88.33 a	72.00 d	46.33 c	585 c
NM-98	60.33 b	44.00	89.00 a	81.00 b	49.67 b	1053 a
NM-92	61.33 b	43.67	89.67 a	87.33 a	50.00 b	750 b
CV	2.56 %	3.42 %	2.38 %	2.28 %	2.57 %	7.31%

Table 4. Yield data of Inqalab Mung as compared to two checks at various locations in National uniform yield trial-2007

Location	DM-3 Grain yield (kg/ha)	Check (NM-06) Grain yield (kg/ha)	Check (NM-92) Grain yield (kg/ha)
NIAB, Faisalabad	1456	1324	1394
NIFA, Peshawar	763	555	728
AZRI, Bhakkar	197	160	202
NIA, Tandojam	1268	1107	1081
BARI, Chakwal	1130	1030	969
ARI, Quetta	362	838	336
ARI, Bahawalpur	851	653	615
QARI, Larkana	1272	1213	751
ARI, Mingora	3620	2969	2708
PRI, Faisalabad	786	1048	674
Kalurkot	1112	973	1112
Average	1092	1003	896

Other characters of 'Inqalab Mung'. Varieties released by Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad though are high yielding and disease resistant yet cannot acclimatize well in KPK owing to different agro climatic conditions in KPK than in Punjab (Khattak *et al*., 2003b). This newly evolved variety 'Inqalab Mung' performed very well throughout Pakistan as depicted in National uniform yield trials 2007 and 2008. Having bold seed size, decreased plant height, stiff stem and short duration as compared to improved varieties prevailing in the country i.e., NM 98, NM-06 and Dera Mung. Besides general preference of farmers, seed size is the main contributing factor towards grain yield (Khattak *et al*., 2003a; 2003b) in mungbean because it fetches higher price compared to small grained varieties (Ali *et al*., 1997). High harvest index % of 'Inqalab Mung' proves to its superior physiological efficiency in partitioning the photosynthates for grain formation leading thereby to distinct increase in the grain yield. Breeding mungbean genotypes, having improved determinate growth habit that can only be achieved through conversion of more photosynthates to flowers, pods and ultimately to grain formation at the start of reproductive growth (Khattak *et al*., 2001). Due to short stature and stiff stem 'Inqalab Mung' is lodging resistant. Despite

Table 5. Yield data of DM-3 (Inqalab Mung) and various entries included in mung (National uniform yield trial-2007) along with contributor's location

Entry	Contributor's location	Average grain yield (kg/ha)
NCM-209	NARC, Islamabad	787
BRM-303	ARI, Bahawalpur	977
97001	PRI, Faisalabad	963
C1/95-3-45	NIA, Tandojam	842
BRM-307	ARI, Bahawalpur	876
NCM 252-7	NARC, Islamabad	883
DM-3	ARI, DI Khan.	1092**
NM-4	NIAB, Faisalabad	844
2 CMG – 501	BARI, Chakwal	876
DM-4	ARI, DI Khan	1038
NCM 257-2	NARC, Islamabad	786
3 CMG -507	BARI, Chakwal	952
NM-06	Check	1003
NM-92	Check	896
97003	PRI, Faisalabad	859

Table 6. Yield data of DM-3 (Inqalab Mung) and various entries included in mung (National uniform yield trial-2008) along with contributor's location

Entry	Contributor's location	Average grain yield (kg/ha)
NM-06	Check	711
NCM-209	NARC, Islamabad	654
BRM-303	ARI, Bahawalpur	766
2 CMG – 516	BARI, Chakwal	758
BRM-307	ARI, Bahawalpur	755
97001	PRI, Faisalabad	725
NM-6	NARC, Islamabad	751
98004	PRI, Faisalabad	806
C1/95-3-45	NIA, Tandojam	762
DM-3	ARI, DI Khan.	831**
NM-5	NIAB, Faisalabad	797
NCM 252-7	NARC, Islamabad	719
DM-4	ARI, DI Khan	819

Table 7. Disease reaction of DM-3 (Inqalab Mung) and in National uniform yield trials 2007 and 2008

Disease	Response
Yellow mosaic virus	Moderately resistant
Charcoal rot	Resistant
Bacterial leaf spot	Resistant
Leaf crinkle virus	Resistant

Source = consolidated disease data of National uniform yield trials.

resistant to MYMV, these two distinct characters of 'Inqalab Mung' are giving edge to the variety for preference over earlier released varieties. The description of 'Inqalab Mung' is given in Table 8.

Management techniques. ***Weed control.*** Water extracts of sorghum, eucalyptus and *Acacia nilotica* were used as a natural weed control approaches in comparison with hand weeding and Stomp 330 EC (Pre-emergence herbicide). The extract of *Acacia nilotica* pods outclassed the other treatments in weeds control and increasing grain yield followed by Hand weeding twice + Stomp 330 EC treatment. The allelo-chemicals existed in the water extract of *Acacia nilotica*'s pods were found to be dual acting agents i.e., controlling obnoxious weeds as well as enhancing mungbean yield. It was observed that extract was instrumental in damaging weeds flora and was also capable of leaching down in lower quantities to the root zone of mungbean thereby promoting growth of the crop (Mansoor *et al*., 2004). The results advocated the need for the use of allelo-chemicals for control of weeds, which was economical and environmental friendly (Singh *et al*., 2006).

***The optimal time of planting*.** For ensuring maximum yield, it is concluded that mungbean sown during spring

Table 8. Description of mungbean variety (Inqalab Mung)

Characters	Ranges
Days to maturity	75-85
Number of primary branches	4-5
Number of secondary branches	5-7
No. of leaves	40-45
Leaf length	13-15 cm
Leaf width	10-12 cm
Days to 50% flowering	32-35
Flowering duration	18-20
Pod length/pod width	8 – 9 cm / 6-7 mm
Pod shape	Semi flat
Mature pod colour	Brownish black
Cluster/plant	10-12
Pod/cluster	7 (average)
Pod/plant	60 (average)
Seed/pod	10 – 12
Seed colour	Dark green
Seed shape	Oval
Coat pattern	Plane
Seed testa texture	Smooth
Seed length	4-5 mm
Seed width	3-3.5 mm
1000 grain weight	52.00 g (average)

on 1st March and Kharif on 1st May were more appropriate from agronomic and ecological perspectives. This was due to the fact that it has increased net return compared to other planting dates, by boosting grain yield and its associated components (maximum number of pods/plant, 1000-grain weight and number of grain/pod). The next significant planting date was 15th of May (Sadiq *et al*., 2006). Mungbean growers can get maximum return if cv. 'Inqalab Mung' is sown during spring and planting is completed in the month of March, moreover, the farmers may also be able to plant second crop on the same field in early June which may not only enhance income of resource poor farmers but will also increase soil fertility due to its nitrogen fixation capability. Rehman *et al*. (2009) also concluded same results for M-1 (Mungbean cv.) for Peshawar valley but with different dates of planting. This alteration may be due to different varieties used in their experiment.

The suitable strain of Rhizobium for effective nodulation. Among rhizobium strains, Vm M1 was more effective in producing more number of effective nodules on 'Inqalab Mung' (Ahmed *et al*., 2006). Vice versa results were true in the plots which were un-inoculated (Achakzai *et al*. 2012).

Phosphatic fertilizer dose. Among phosphatic fertilizer doses the dose of 20:50 $N:P_2O_5$ kg/ha was more economical than 20:70 $N:P_2O_5$ kg/ha in terms of net return.

The proper seed rate for standardizing plant population. It is concluded from the experimental findings that seed rate of 40 kg/ha with row spacing of 30 cm, followed by seed rate of 40 kg/ha with row spacing of 20cm has resulted in better plant stand establishment and productivity of Cv. 'Inqalab Mung' (Ahmad *et al*., 2004).

Conclusion

'Inqalab Mung' variety is suitable for edible purpose and contains 20% proteins, 306 Kcal energy, vitamin-A 5%, iron 6.6%, Zinc 3.4% and amino acids 11%. 'Inqalab Mung' is a high yielding, bold seeded, disease resistant and dual nature variety fit for spring and kharif seasons. The variety is erect with main stem length 45 cm having indeterminate plant type with non-shattering habit. Seed is bold, oval shaped and dark green in colour. 'Inqalab Mung' variety is resistant to common diseases found in Pakistan.

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