Research Article

New High Yielding Mungbean [(*Vigna radiata* (L.) Wilczek] Variety "Inqalab Mung" for the Agro-Climatic Conditions of KPK

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Abstract | Inqalab Mung (DM-3) was developed through cross between VC1482 C (AVRDC line Vigna cross, bold seeded, small stature and susceptible to Mungbean Yellow Mosac Virus (MYMV) and NM-92 (a promising variety of Pakistan, bold seeded, high yielding and MYMV resistant) at Agricultural Research Institute, Dera Ismail Khan. Inqalab Mung was tested in various experiments for production technology and yield trials for its performance. Result showed that 40 kg ha^{-1} seed rate with 30 cm row spacing, fertilizer dose @ 20:50 kg ha^{-1} 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 National Uniform Yield Trial (NUYT)-2007 with an average yield of 1092 kg ha^{-1} at 12 locations across country, with highest grain yield of 3620 kg ha^{-1} at Agricu*ltual Research Station* ARS, Mingora, Swat, Khyber Pakhtoon Khawa. Again in NUYT-2008, Inqalab Mung outclassed among 13 candidate lines across 13 locations. It gave the highest grain yield of 1560 kg ha^{-1} at NIAB, Faisalabad. Provincial Seed Council (PSC), Khyber Pakhtoon Khawa, approved Dera Mung-3 as "Inqalab Mung" for general cultivation in KPK. Inqalab Mung has 28-36% high grain yield potential compared to the standard variety Niab Mung-98 and parent Niab Mung-92 along with resistance to charcoal rot, cercospora leaf spot and Yellow mosaic virus.

Received | 20 December, 2016; **Accepted** | 09 April, 2017; **Published** | June 29, 2017
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Citation | Mansoor, M. Amanullah, Z. Islam, S. Muhammad, M. Umair, M. Ayaz, A.A. Khan, M. Asif and Y. Sakina 2017. New high yielding mungbean [(*Vigna radiata* (L.) Wilczek] variety "Inqalab Mung" for the agro-climatic conditions of KPK. *Pakistan Journal of Agricultural Research*, 30(2): 173-179.
DOI | http://dx.doi.org/10.17582/journal.pjar/2017/30.2.173.179
Keywords |Mungbean (*Vigna radiata* (L.) Wilczek, Inqalab Mung variety, Grain yield, Bold seeded

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek], is an indigenous vegetable legume and one of the most important pulse crops in Southeast Asia. Being rich in digestible protein (24%), mungbean is utilized in the cereal-based diets (Khattak et al., 2003). 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 of 70-90 days (April to June) in rice wheat cropping system is suitable to raise a catch crop of mungbean. Being low input requiring, short duration, high value crop and restorative crop, mungbean, find its place in rice-wheat and other crop rotations (Achakzai et al., 2012). Mungbean, being leguminous crop fixes nitrogen thereby improving soil fertility and requires comparatively lesser irrigation than various field crops (Khan et al., 2008). Inclusion of mung

Table 3: *Meteorological Data.*

Month	2007					2008				
	Temperature (°C)		Relative Humidity		Rainfall (mm)	Temperature (°C)		Relative Humidity		Rainfall (mm)
	Max	Min	0800 Hrs.	1400 Hrs.		Max	Min	0800 Hrs.	1400 Hrs.	
April	35	18	72	52	19.5	37	21	74	45	20
May	39	22	71	42	3	41	23	72	49	--
June	42	26	63	34	1	39	26	78	51	39.5
July	38	27	75	46	60	38	27	79	52	46
Aug.	37	26	78	57	102	36	25	83	61	42.5
Sept.	35	24	79	57	16	36	24	82	58	50
Oct.	33	33	76	48	--	30	19	81	60	--

Source: *Arid Zone Research Center, Dera Ismail Khan, KPK, Pakistan.*

bean in cereal cropping system can increase farm income, improve soil productivity, save irrigation water and can boost sustainability of agriculture (Hussain et al., 2012). Mungbean cultivars being cultivated in Pakistan have comparatively longer growth duration (90-110 days), indeterminate growth habit (Jahan and Golam, 2012), low yielding (400 kg ha^{-1}), small seed, susceptible to YMV and insects (sucking and chewing types) (Khattak et al., 2006; Rehman et al., 2009). It is therefore research priority to develop cultivars having short growth duration (55 to 65 days), high yield potential (up to 2000 kg ha^{-1}), synchronized maturity to facilitate single harvesting, resistance to MYMV, Cercospora leaf spot and having bold shiny seeds being preferred in the market (Aslam et al., 2010). Short duration mungbean varieties can be grown as intercrops with cotton, maize and vegetables. 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^{-1}), which is early maturing, with bold seeds and possessing resistant against MYMV disease. The variety has been recommended for cultivation in both spring and summer seasons. 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.

We are giving here the detailed developmental and evolution process of this new high yielding bold seeded mungbean variety.

Materials and Methods

Agro-ecological conditions

Dera Ismail Khan is situated in the extreme south of Khyber Paktoon Khawa (KPK) of Pakistan and lies in between 31° 49′ N latitude and 70° 55′ East longitude. The soils of the area are calcareous in nature, deficient in organic matter, nitrogen and phosphorus and adequate to marginal in potassium. The climate is arid to semi-arid. It is hot and dry in summer with moderate spells during monsoon season. The elevation ranges from 400 to 4000 feet above sea level. The mean maximum temperature in summer and mean minimum temperature in winter are 45 °C and 8 °C, respectively. The mean annual precipitation ranges from 150-250 mm and relative humidity varies from 51% in June to 78% in October. The materological data, including maximum, minimum temperature, relative humidity and rain fall, is given in Table 3.

Breeding Material and Process

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, during kharif 1998. 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 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 of line was tested in Preliminary Yield Trial (PYT) (Figure 1a, 1b and 1c) 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 analyzed according to Steel and Torrie (1980).

Results and Discussions

Inqalab Mung (DM-3) was tested in Major Yield Trial (MYT) (Figure 2a, 2b and 2c), Advanced Yield Trial (AYT) (Figure 3a, 3b and 3c) and National Uniform Yield Trials (NUYTs) (Figure 4) during 2007 and 2008 (Figure 5). Twenty one lines were evaluated in PYT during 2005. Inqalab Mung (DM-3) gave better yield (1130 kg ha^{-1}) against check variety NM-92 (1038 kg ha^{-1}) as shown in Figure 1c. In MYT, Inqalab Mung (DM-3) out yielded all other lines including check with grain yield 1273 kg ha^{-1} as shown from Figure 2c. In AYT (Figure 3c), Inqalab Mung (DM-3) again gave highest yield (1056 kg ha^{-1}) in the trial. In mung 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 (Figure 6). The candidate

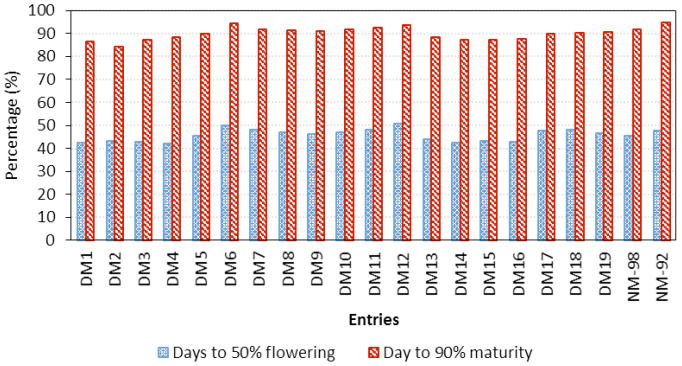

Figure 1a: *Performance of DM-3 for percentage flowering and maturity in preliminary Yield Trial-2005 (Spring).*

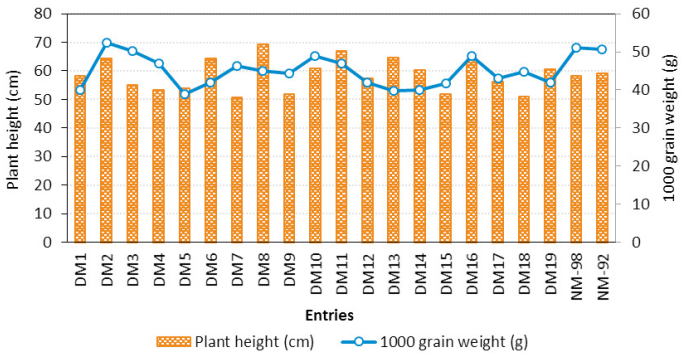

Figure 1b: *Performance of DM-3 for plant height and grain weight in preliminary Yield Trial-2005 (Spring).*

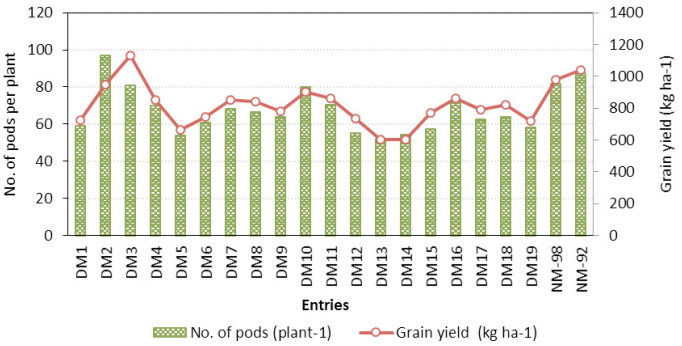

Figure 1c: *Performance of DM-3 for no. of pods and grain yield in preliminary Yield Trial-2005 (Spring).*

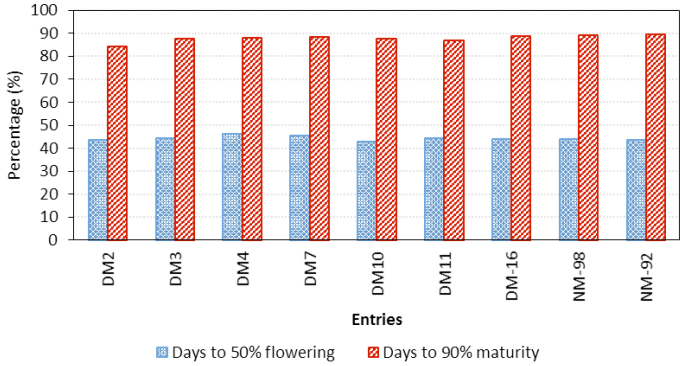

Figure 2a: *Performance of DM-3 for percentage flowering and maturity in Major Yield Trial-2005 (Kharif).*

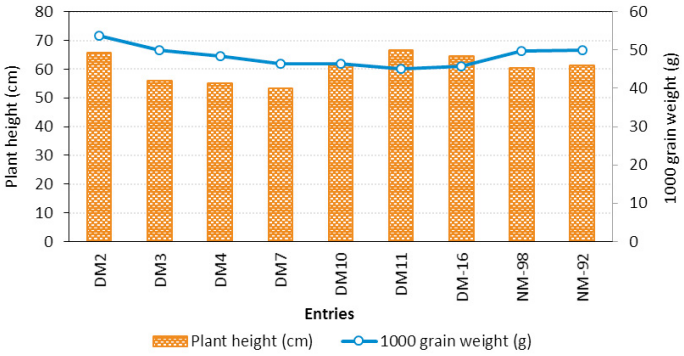

Figure 2b: *Performance of DM-3 for plant height and grain weight in Major Yield Trial-2005 (Kharif).*

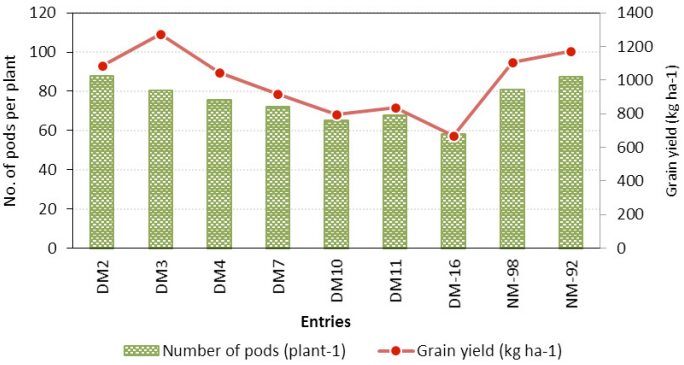

Figure 2c: *Performance of DM-3 for no. of pods and grain yield in Major Yield Trial-2005 (Kharif).*

variety Inqalab Mung (DM-3) was tested at CDRI, NARC, Islamabad for disease reaction (Table 1), 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). Four experiments were designed to investigate the integration of some management techniques for increased productivity of Inqalab Mung. A comparative study was designed to investigate the efficacy of various weed management strategies for mungbean crop. 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 second experiment was conducted for exploring optimal time of planting for ensuring maximum yield." It is concluded that mungbean sown during spring 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^{-1}, 1000-grain weight and number of grain pod^{-1}). 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.

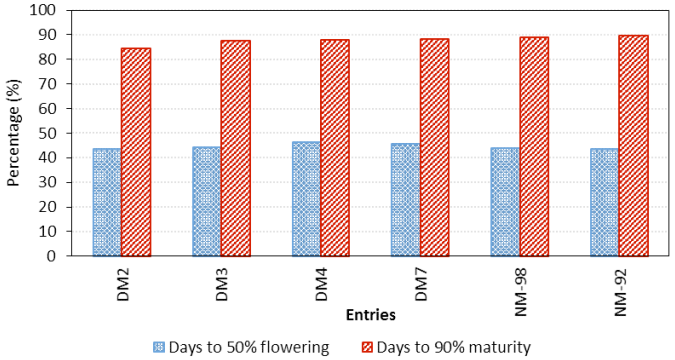

Figure 3a: *Performance of DM-3 percentage flowering and maturity in Advanced Yield Trial-2006.*

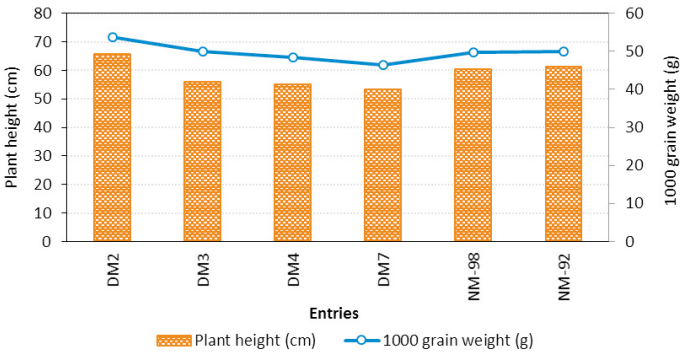

Figure 3b: *Performance of DM-3 for plant height and grain weight in Advanced Yield Trial-2006.*

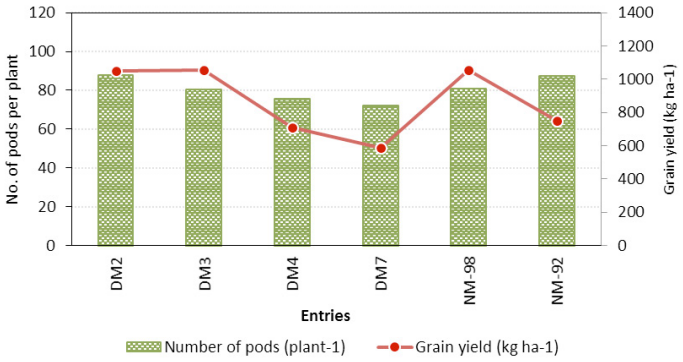

Figure 3c: *Performance of DM-3 for no. of pods and grain yield in Advanced Yield Trial-2006.*

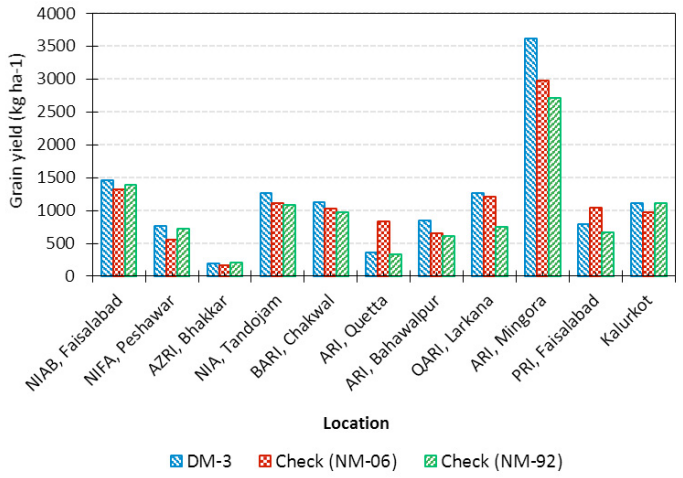

Figure 4: *Yield data of Inqalab Mung as compared to two Checks at various locations in National Uniform Yield Trial-2007.*

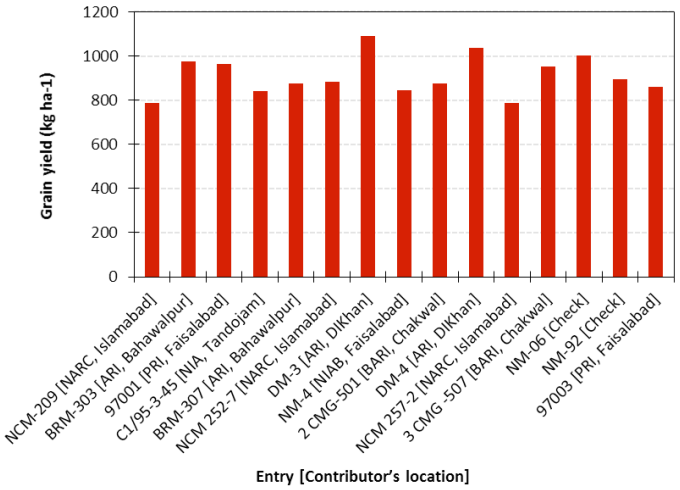

Figure 5: *Yield data of various entries included in Mung National Uniform Yield Trial-2007 along with Contributor's location.*

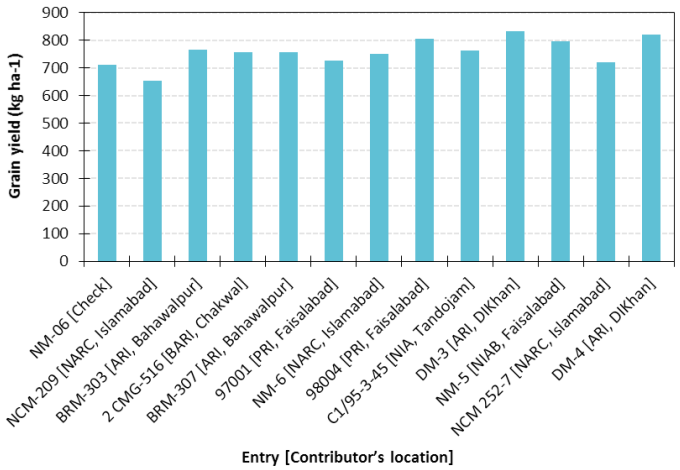

Figure 6: *Yield data of various entries included in Mung National Uniform Yield Trial-2008 along with Contributor's location.*

Table 1: *Disease reaction of DM-3 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.*

Table 2: *Production technology for Inqalab Mung.*

Soil	Sandy Loam
Sowing Time	Spring: 1st March to 15th March Kharif: 1st May to 15th May
Fertilizer	20:50: kg ha^{-1}
Row spacing	30 cm
Inoculum	VmM1 @ 1.25 kg^{-1}
Weed control	Manual or Pre-emergence
Harvesting	Manual
Threshing	Mechanical thresher

The third experiment was aimed at "exploring suitable strain of Rhizobium for effective nodulation and phosphatic fertilizer dose for getting maximum yield of mungbean". Among rhizobium strains, it is concluded that Vm M1 was more effective in producing more number of effective nodules (Ahmed et al., 2006). Vice versa results were true in the plots which were un-inoculated. While among phosphatic fertilizer doses the dose of 20:50 N:P_2O_5 kg ha^{-1} was more economical than 20:70 N:P_2O_5 kg ha^{-1} in terms of net return. The fourth experiment was carried out "To determine proper seed rate for standardizing plant population per unit area". It is concluded from the experimental findings that seed rate of 40 kg ha^{-1} with row spacing of 30 cm, followed by seed rate of 40 kg ha^{-1} with row spacing of 20 cm has resulted in better plant stand establishment and productivity of Cv. Inqalab mung (Ahmad et al., 2004). Production technology package evolved through conduct of different trials on planting time, planting density and inoculums + fertilizer is given in Table 2.

Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad has evolved NM-92, NM-98, NM-6 and NM-12, high yielding and disease resistant varieties of mungbean through hybridization and mutational breeding for Punjab province (Ali et al., 1997). Although these are good varieties yet cannot acclimatize well in KPK owing to different agro climatic conditions in KPK than 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; b) 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 of Inqalab Mung is lodging resistant. Despite resistant

to MYMV, these two distinct characters of Inqalab Mung are giving edge to the variety for preference over earlier released varieties.

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 Khrif seasons. Its grain yield recorded during spring was 1130 kg ha^{-1} and in kharif season it yielded 1273 kg ha^{-1}. 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 color. Inqalab Mung variety is resistant to common diseases found in Pakistan.

Authors Contribution

MM conceived the idea, conducted trials and wrote the manuscript. AU, ZI, SM, MU and M Asif helped in writing the manuscript. ZI did the overall management of the manuscript and SM provided the technical guideline. AAK, YS and m Ayaz helped in data collection and analysis. MU and M Asif prepared bar charts.

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