Nepal

Testing and promotion of mungbean in cereal fallows in the low hills and *terai* agroecosystems of Nepal

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Abstract

In Nepal, grain legumes are an important part of the daily diet and are grown both as sole-intercrop. With the decline of chickpea cultivation due to high incidence of pests and the reduced popularity of grasspea because of consumers' increasing awareness of its toxicity, Nepalese farmers have been searching for other leguminous crops to grow. Testing and promotion of mungbean was initiated as part of a drive to integrate legumes into cereal fallows (land that remains fallow after the harvest of rice, maize or wheat) in 2002. After mungbean varieties from the Asian Vegetable Research and Development Centre (AVRDC) were tested in the summer and autumn seasons in 2002, huge demand for mungbean was observed. This led to massive promotion of mungbean in 2003 through farmer participatory trials and informal research and development (IRD) across 13 districts in the low hills and *terai* ecosystems of the country. Planted mostly in fallows without the application of any supplemental fertilizer or irrigation, the mungbeans had generally low yield levels. However, the overwhelming majority of participant farmers preferred AVRDC varieties over local cultivars for most agronomic and post harvest traits including earliness, yield, pod and grain size, grain colour, smell and taste. Improved mungbean varieties hold great promise as a catch crop in diverse cropping patterns.

Introduction

The role of grain legumes in the food security of the Nepalese people cannot be overemphasized. A wide variety of grain legumes including beans, peas, lentils and grams are grown across diverse agro-climatic regions that stretch from about 60 m to more than 3,000 m. Legumes are an important constituent of the people's daily diet and are grown in various cropping patterns as sole- or intercrops (Neupane, 2003; Subbarao *et al.*, 2000). Mungbean is a relatively unfamiliar crop for most Nepalese farmers, yet it is one of the popular pulses among consumers in the urban areas. Virtually, all demands of consumers are met through imports from India (Trade Promotion Centre pers. com.).

The National Grain Legumes Research Programme (NGLRP) of the Nepal Agricultural Research Council (NARC) has recommended Pusa Baisakhi (Joshi *et al.*, 2003a; Neupane *et al.*, 2003) which is grown in the *terai* on a limited scale, both for grain and green manuring purposes, though it is not well-liked by the farmers because of its unpleasant smell (Joshi *et al.*, 2003b). Similarly, other available varieties are unpopular because of their characteristics, such as unpleasant smell when cooking, short pods, small grains, high incidence of mungbean yellow mosaic virus (MYMV), and the drudgery associated with multiple pickings (Joshi *et al.*, 2003b).

Rice followed by wheat is the major crop rotation in the *terai* and there is a 65- to 75-day interval after the harvest of wheat and before transplanting rice. This fallow period could be exploited for crop diversification and for improving soil fertility. Short-duration mungbean fits very well as a catch crop in this window. Mungbean can also be grown after oilseed rape, potato, and even in the long-standing water areas where land remains fallow after harvest of rice because of excess moisture in the field.

Materials and Methods

Participatory evaluation of mungbean in cereal fallows and other rotations was initiated in 2002 and involved various stakeholders. The activities were Mother trials[1], Baby trials[2], Informal Research and Development (IRD)[3], and seed production of farmer-preferred varieties. Most activities were implemented by the Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) while a few trials were conducted by Local Initiatives for Biodiversity Research and Development (LI-BIRD).

[1]Mother Trials (MT) are researcher-designed, farmer-managed with farmer level of inputs. Can have many cultivars in several locations, one replicate per location. In MT, yield and maturity are measured by researchers while consultative evaluation is done for other traits.

[2]Baby Trials (BT) are farmer-managed with farmer level of inputs, one or two new cultivars per farmer are compared with local cultivar or second new variety. Evaluation of farmers perceptions the basis for the assessment of entries in the BTs.

[3]Informal Research and Development (IRD), an alternative form of participatory varietal selection (PVS) is less intensive and is designed to improve the flow of new genetic materials to farmers and facilitate their dissemination through farmer-to-farmer networks.

The new short-duration mungbean varieties were obtained from the Asian Vegetable Research and Development Centre (AVRDC). The National Grain Legume Research Programme (NGLRP) and District Agricultural Development Offices (DADOs) provided technical support in the monitoring of field activities. The Centre for Arid Zone Studies (CAZS) was responsible for overall coordination of the activities.

The participatory trials were managed entirely by the farmers. Input levels, time and method of planting, crop management, intercultural operations, etc. were all decided and implemented by the farmers. Field staff provided pest identification and plant protection support to the farmers. Relevant agronomic data and other observations were recorded regularly. The crop was monitored and its performance was evaluated by the researchers and farmers through farm walks and focus group discussions. A team of multidisciplinary professionals and farmers also monitored the standing crop. Preference ranking and qualitative assessment of the varietal traits were carried out relative to local cultivars.

Data analysis

The data collected from the trials were compiled and analyzed using Excel, Minitab, and Mstat-C packages. Both descriptive analysis and inferential tests such as t-test and analysis of variance (ANOVA) were employed. Four of the mother trials conducted in Jhapa and Saptari had farmers' local varieties, while in other locations local varieties were not available for comparison. Data were analyzed and results were presented separately. In most cases, due to too few replications per district, intra-district ANOVA testing was not possible for varietal comparison.

Adaptive observation on summer-planted mungbean

In 2002, five mungbean varieties namely NM-92, NM-94, VC-6372 (45-8-1), KPS 1, and VC 3960-88 were introduced from AVRDC. The trial set was received rather too late for the normal planting season, and so planting was done on May 16, 2002 in a farmer's field in Chitwan, just for general observation and for increasing the seed. Farmers' perceptions of the test varieties were collected during periodic field monitoring.

Adaptive observation on autumn-planted mungbean

The seeds obtained from the summer season planting were used for adaptive observation trials during the post-rainy season in 2002 in Chitwan (400 m) and Dhankuta in the low hills (600 m), and in Kapilbastu in the *terai* environment.

In the hill sites, the crop was planted in maize fallows during late August to mid-September, while in the *terai* location, it was planted in early October after the harvest of short-duration rice. These fallows were traditionally used for grazing livestock. Five mungbean varieties from the preceding summer trial and two additional varieties, namely (VC 6173B-6 and VC 6153 B-20G) obtained from NGLRP, were tested. Relevant observations were made and farmers' feedback was collected.

Participatory varietal selection (PVS) trials in spring

The PVS trials included mother trials, baby trials, and a more extensive approach - informal research and development (IRD). Six mungbean varieties (NM-92, NM-94, VC-6372 [45-8-1], VC 3960-88, VC 6137B-6 and VC 6153B-20-G) were obtained from AVRDC. Since the seeds of VC 6137B-6 and VC 6153B-20-G varieties were limited, seed increase was planned for those varieties. The remaining four varieties were tested in Mother trials conducted across five locations while Baby trials and IRD were conducted in parts of the 13 districts covering both the low hills and *terai* (Table 1).

Table 1. Summary of participatory trials and seed production on mungbean in spring 2003

District and agro-ecological zone	Number of trial		IRD and seed production (ha)
	Mother	Baby	
Hill districts			
Dhankuta	-	6	-
Kaski	-	12	-
***Terai* districts**		-	-
Jhapa	3	12	0.8
Morang	-	12	-
Sunsari	-	12	-
Saptari	3	12	0.8
Siraha	-	12	-
Chitwan	3	12	1.0
Kapilbastu	3	12	0.8
Banke	-	6	-
Bardiya	-	12	-
Kailali	-	12	-
Kanchanpur	3	12	0.8
Total	15	144	4.2

- Indicates activity not done

Each variety in the mother trials occupied 50 m², while each variety in the baby trials was grown on an area of 100 m². The trials, IRD, and seed production in spring were planted between 6 March to May.

Results and Discussion

Mother trials

The amount and distribution of rainfall during mungbean cropping was adequate and there was little evidence of moisture stress. (Figure 1).

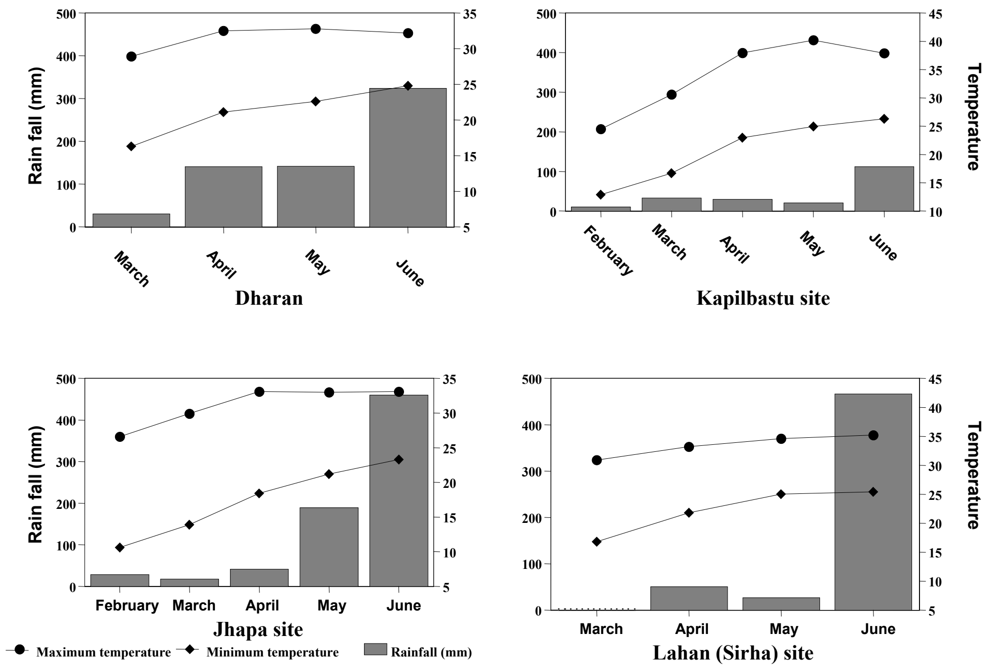

Figure 1. Maximum and minimum temperatures and rainfall recorded at the nearest station from the mungbean testing locations in Jhapa, Saptari/Siraha (Lahan) and Kapilbastu, 2003

Inherently poor soil fertility was seen to be a major abiotic stress for growth which was stunted in most of the trials. Based on the farmers' own judgment, only 8% of fields were characterized as having reasonable fertility, 65% medium fertility, and 27% poor in fertility. However, none of the farmers applied any fertilizer for mungbean trials. Some of the fields were infested with aphids, thrips, and bugs. Appropriate control measures were delayed because of unfamiliarity with the crop. In many cases, the first flush of flowers dropped or pods shrivelled due to incidence of sucking pests. It was only after appropriate pest control measures were applied that farmers benefited from the second and third flushes of the crop. For the above reasons, yield levels of mungbean were lower than expected. However, the mungbean trials were a useful learning exercise for farmers and other stakeholders.

Although overall yield levels were not very high, all test varieties produced significantly higher yields (P=0.03) with bolder seeds (P=0.00) and matured earlier (P=0.00) than the farmers' varieties. However, all new varieties had some similar traits with local cultivars (Table 2). Similarly there was no significant difference among the test varieties in most of the growth and yield attributes. Nevertheless, significant interactions were observed between the varieties and test locations. Since this is the first trial and yield levels are low, the data from all locations were combined and only the mean is presented. However, the results indicated that each variety may have its relative advantage in particular sites, and this should be verified further in future trials.

Comparison of the four AVRDC lines showed no difference between these varieties for any traits except for the flowering time, although there was interaction between varieties and districts (Table 3). Since the yield is low, individual district yields are not given. These results are based on only three or no replications and therefore need to be interpreted cautiously.

Table 2. Comparison of new and local varieties of mungbean in mother trials in Jhapa and Saptari districts, spring season 2003

Variety	Means of varietal parameter								
	Days to:		Plant:		Number of:				
	50% flowering of first flush	First picking	Population m^{-2} at harvest	Height (cm)	Pods $plant^{-1}$	Unfilled pods	Grains pod^{-1}	100 grains weight (g)	Grain yield (kg ha^{-1})
NM 92	41	66	14	22	12	2	9	4.7 [a]	329[a]
NM 94	43	66	15	22	11	2	9	4.4 [b]	345[a]
VC 3960-88	42	66	12	25	12	2	9	4.5 [b]	377[a]
VC 6372 (45-8-1)	42	66	13	26	14	1	9	4.7 [a]	346[a]
Farmers' Local	49	73	17	33	18	4	11	1.3 [c]	248[b]
F-test	**	**	NS	NS	NS	**	NS	**	*
LSD (α=0.05)	1.9	2.4				0.8		0.2	75.8
CV%	2.8	2.2	32.1	22.4	29.1	22.6	14.5	1.5	33.4

** = significant at 1% level, * = significant at 5% level, NS = not significant, a = varieties at par, b = varieties significantly inferior to varieties grouped as 'a', c = varieties significantly inferior to both 'a' & 'b' group of varieties.

Table 3. Comparison between four improved varieties in mother trials in Jhapa, Saptari and Kapilbastu districts, spring season 2003

Variety	Means of varietal parameter							
	Days to:		Plant:		Number of:			
	50% flowering of first flush	First picking	Population m^{-2} at harvest	Height (cm)	Pods $plant^{-1}$	unfilled pods	Grains pod^{-1}	Grain yield (kg ha^{-1})
NM 92	44	66	16	27	15	2	10	397
NM 94	46	65	15	30	14	3	9	352
VC 3960-88	45	66	13	25	14	3	9	338
VC 6372 (45-8-1)	45	66	16	31	16	2	10	398
F-test								
District (D)	NS	NS	NS	NS	NS	NS	NS	NS
Variety (V)	**	NS	NS	NS	NS	NS	NS	NS
D×V	**	NS	NS	*	**	NS	*	**
CV%	1.2	2.4	13.5	16.9	10.4	6.5	6.5	11.24

** significant at 1% level, * significant at 5% level, NS not significant at 5% level.

Baby trials

In the baby trials, emphasis was made on the incorporation of farmers' perspectives in the varietal evaluation. However, some agronomic attributes were also recorded. (Table 4). The baby trial results also showed that NM92 varied significantly in plant stand with VC6372 and VC3960-88. There was no difference among other varieties in any of the traits in any of the combinations across the test locations. All of the farmers preferred the new varieties over the local ones on the basis of various agronomic and post harvest traits. The traits that farmers considered important for the evaluation were adaptation to low fertility conditions, pests and stress tolerance, earliness of the crop, plant type, pod and grain size, seed coat colour, smell and taste.

Table 4. Paired comparison of mungbean varieties in Baby trials in Jhapa, Saptar and Kapilbastu districts, Spring 2003

No of Replicates	Variety combination	Varietal means over replicates across districts			
		Days to 50% flowering for first flush	Plant stand m^{-2} at harvest	Days to first picking	Grain yield (kg ha^{-1})
13	VC3960-88	45	15	65	379
	VC 6372 (45-8-1)	45	14	65	435
	T-test	*NS*	*NS*	*NS*	*NS*
5	NM 92	44	13	67	325
	VC 6372 (45-8-1)	44	15	68	432
	T-test	*NS*	*	*NS*	**
5	NM92	44	15	66	433
	VC3960-88	44	13	68	476
	T-test	*NS*	**	*NS*	*NS*
5	NM94	45	12	64	331
	VC3960-88	45	13	64	387
	T-test	*NS*	*NS*	*NS*	*NS*
7	NM94	44	11	63	387
	VC 6372 (45-8-1)	44	11	67	407
	T-test	*NS*	*NS*	*NS*	*NS*

** = significant at 1% level, * = significant at 5% level, NS = not significant at 5% level.

Farmers preferences ranking

Farmers' preference rankings largely correspond with the relative yield ranks of the varieties within the test districts (Table 5).

Table 5. Farmers' preference ranking of mungbean varieties in the Mother trial

	Jhapa		Saptari		Kapilbastu
	Female group	Male group	Female group	Male group	Mixed group
VC 3960-88	I	I	IV	III	III
VC 6372 (45-8-1)	II	II	III	II	I
NM 94	III	III	II	III	II
NM 92	IV	IV	I	I	III
Local	V	V	V	IV	Not included

There was not a single case where local variety was considered superior over any of the test varieties (Figure 2).

The most remarkable responses were found in the case of pod, grain size and colour, smell, and taste. In terms of grain yield, none of the new varieties were perceived to be worse than the locals. With regard to stress and pest tolerance, most of the farmers found no difference among local and improved varieties.

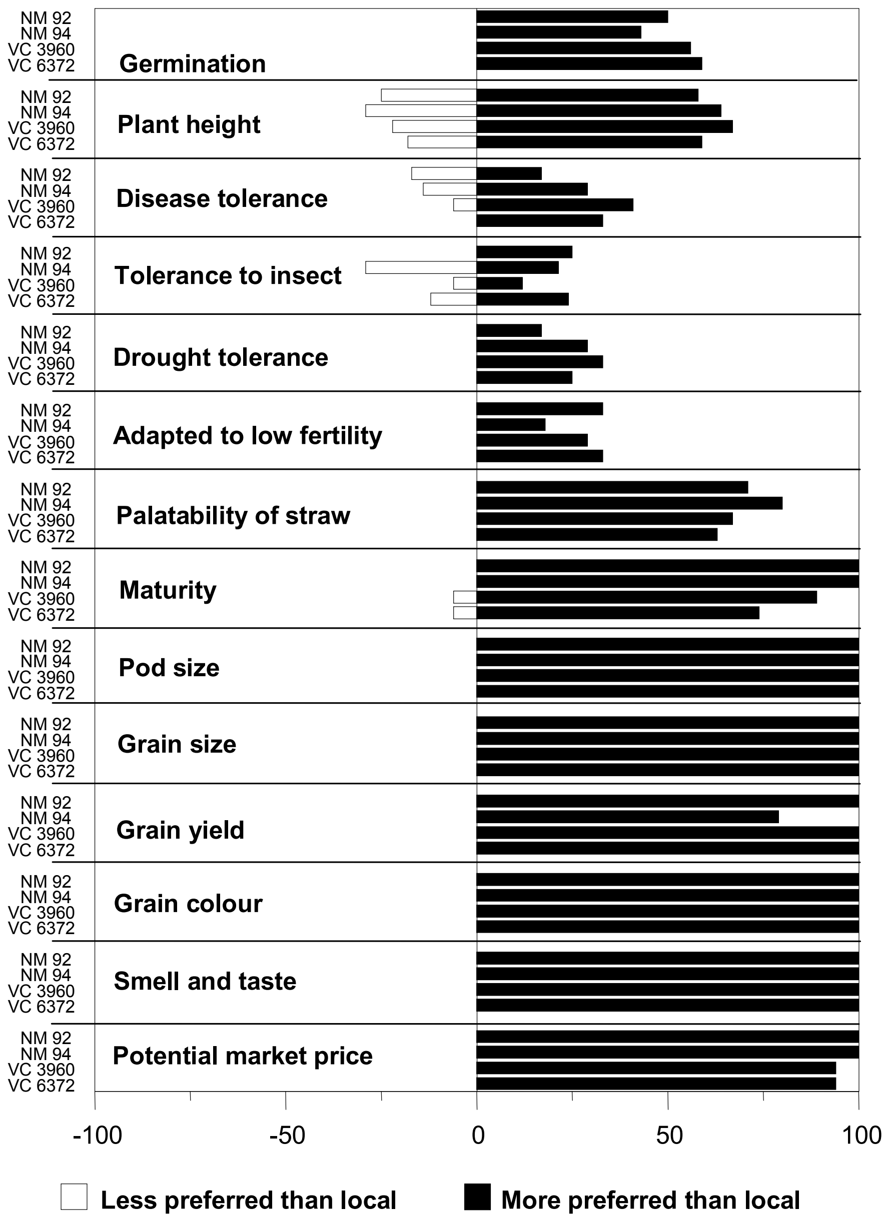

Figure 2. Farmers' perceptions of new mungbean varieties relative to local varieties, 2003

Overall perceptions of the trial participants and other peer farmers who took part in the focus group discussions are summarized below:

- All test varieties were superior to the existing farmers' varieties and the farmers were interested in saving seeds of all the varieties for further testing.
- The test varieties mature about two weeks earlier than local varities.
- Shorter plants and longer pods of the new varieties made picking easier.
- Harvesting of new varieties was completed in three pickings, while the local cultivars required five.
- The local cultivars had a characteristically unpleasant smell, while the improved ones smell better.
- The *dal* of test varieties took less time to cook and was tastier than local cultivars.
- Farmers estimate that new varieties could fetch 50% higher price than local varieties.
- The new varieties need reasonably fertile soils and better management, including fertilizer application, few irrigations, weeding etc., for satisfactory harvest.
- The new varieties will be more popular if they are grown as intercrop with spring maize.

One of the major indicators of farmers' willingness to adopt new varieties is the expressed intention of seed saving by the trial participants and seed demand by their neighbors.

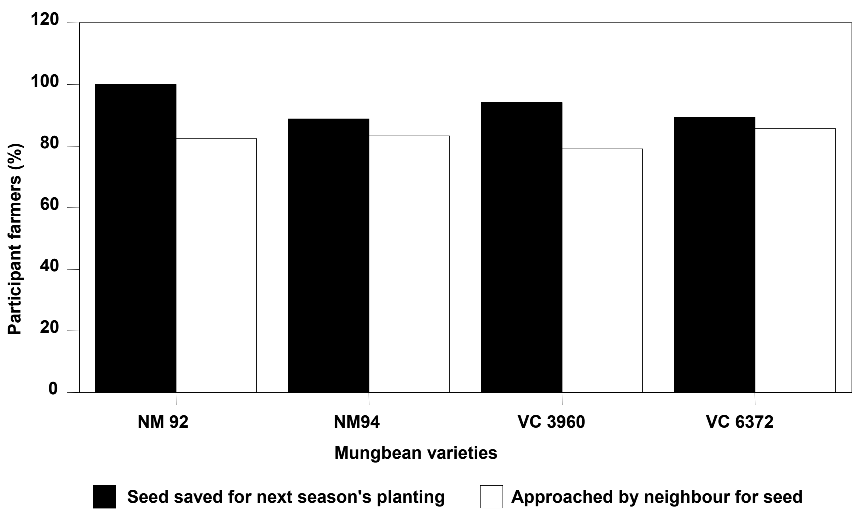

Figure 3. Seed saving by trial participants and seed demand by their neighbours for new mungbean varieties.

The data in Figure 3 strongly indicate farmers' acceptance of the new varieties as reflected by their willingness to grow them in the following season. This was further confirmed by the fact that many of the farmers refused to sell back the seed to the project. Some of them expressed their plan to plant the saved seeds in more than half a hectare of land in the next season.

Other activities

Mungbean adaptation in the summer season

Plant growth of all varieties was satisfactory and there was no problem of pests, except for some incidence of chewing insects. The first flush of the test varieties was harvested between 55 to 65 days and harvesting was completed within 75 days after planting (Table 6).

Table 6. Performance of AVRDC mungbean lines in Chitwan during summer 2002

Observation	Mungbean line				
	NM-92	NM-94	VC-6372 (45-8-1)	KPS 1	VC 3960-88
Days to flowering	35	30	35	40	35
Days to fruiting	45	40	45	50	45
Days to first picking	60	55	60	65	60
Plant height (cm)	80	80	80	90	80
Grain yield (kg ha^{-1})	567	394	399	913	221

It was the first time the farmers tried mungbean cultivation in Shaktikhor village (400 m) in Chitwan, so there was no opportunity to compare the new varieties with any locals. Participants and neighboring farmers had the opinion that all varieties were well-adapted to local conditions, and that the crop would have been better if the trial been planted earlier. They also told the researchers that high moisture in the soil caused excessive vegetative growth at the expense of the number of pods. Given the conditions, the farmers were satisfied with the performance of all test varieties and opted to keep half of the seeds of KPS 1 variety to continue growing mungbean in the following seasons.

Mungbean as an autumn crop in the low hills and the terai

Testing mungbean adaptation as an autumn crop in the low hills and the *terai* of Nepal is a new concept. The promising performance of all mungbean varieties during summer gave us confidence to test mungbean during autumn. Most of the trials were partially damaged by wild or stray animals, as there was no other crop grown around the trial areas. Thus, the data could not be analyzed statistically. However, farmers could observe the growth pattern of the crop and took some grain from the trials.

In the *terai*, where planting was done in the first week of October, the crop suffered from excess soil moisture caused by heavy rain just after emergence, from cold temperatures, and high incidence of powdery mildew during the reproductive stage. In spite of these, farmers preferred all the new varieties because of their long pods and bold grains, and were willing to test these varieties in the spring.

Varieties planted in August-September in Dhankuta and Chitwan yielded 500 to 650 kg ha^{-1} (data not shown). All the participants saved their seeds for next season planting. This established that mungbean can be successfully grown in the autumn season in the low hills and *terai* if soil is well-drained. Planting can be completed within the first week of September to escape extreme cold and incidence of powdery mildew during the fruiting stage of the crop.

Confirmation of post rainy season adaptation of mungbean

In response to a large demand from farmers and field staff in Chitwan and Morang districts, some IRD kits were provided for autumn planting after the harvest of maize in August 2003. Some farmers tested the varieties as sole crop while others in Morang tried them as an intercrop with cucumber grown in the inter-row spaces. Based on the farmers' reports, their yields varied from about 500 kg to 1,200 kg ha^{-1} (data not shown). In some of the fields, there were incidences of aphids, which were later put under control through one or two sprays with Dimethoate. It seems that mungbean can be planted in autumn season in cereal fallows in Nepal.

Conclusion

Mungbean is a very promising crop for Nepal. The improved varieties from AVRDC are well-adapted to the spring, summer and autumn seasons in the low hill and *terai* agroecosystems. With short maturity periods, they fit as a catch crop into various cereal-based rotations such as rice-mungbean, rice-wheat mungbean, rice-potato-mungbean, maize-mungbean, maize-mungbean-wheat, etc. There are further possibilities in the intercrop mungbean with maize and vegetables. Farmers invariably preferred the improved varieties to the existing local cultivars, based on various agronomic and post-harvest attributes. Dishes prepared from improved varieties were relished more by Nepalese farmers and their families. Considering the substantial import of various pulses, there is great market potential for mungbean at least up to the level of import substitution, if not for export. With these virtues, mungbean appears to be a promising commodity for food security and disposable income of farmers across the entire *terai*, valleys, and low hills of Nepal.

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Development of mungbean (*Vigna radiata* (L.) Wilczek) varieties for rice and maize- based systems in Nepal

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Abstract

Mungbean (*Vigna radiata* (L.) Wilczek) is an important short duration grain legume crop grown in irrigated or partially irrigated *terai*/inner *terai* of Nepal. It is an important crop for supplying cheap protein in the diet of the people and for restoring the soil fertility. The importance of inclusion of mungbean in cereal based cropping system has recently been recognized. Mungbean is grown in an area of 12,000 ha with an average yield of 0.5 t ha^{-1}. The share of mungbean in the area of grain legumes is approximately 4%. With increase in irrigated area, the area under mungbean likewise increases in central and eastern *terai*. There is a vast scope for area expansion both under rice-based and maize-based cropping pattern, if suitable varieties and production technologies are made available. Earlier recommended variety Pusa Baisakhi is susceptible to Mungbean Yellow Mosaic Virus (MYMV) and *Cercospora* Leaf Spot (CLS) diseases. Recent research efforts led by the National Grain Legume Research Program have resulted in the identification of a number of high yielding and MYMV resistant varieties, e.g. VC 6372 (45-8-1), VC 6370 (30-65), and VC 6368 (46-7-2) which are being evaluated in farmer participatory trials. VC 6372 (45-8-1) is preferred by farmers because of its bold seeds, high yields, and resistance to MYMV, and it is already in the process of release. Research and development activities and future strategies in mungbean research are discussed in this paper.

Key words: Mungbean Nepal, MYMV resistant variety, cropping patterns

Introduction

Mungbean (*Vigna radiata* (L.) Wilczek) is an important short duration grain legume crop supplying a substantial portion of protein to the cereal-based diet of the Nepalese people. It is regarded as a quality pulse for its protein-rich seed and excellent digestibility, especially when combined with cereals (Thirumaran & Seralthan, 1988).

Grain legumes occupy an area of about 311,100 ha with a total production of 256,968 mt and the average productivity of 0.826 t ha^{-1} (Anon, 2003), which represents 10. 5 % of the total cultivated area of the country. Lentil, chickpea, pigeonpea, blackgram, soybean, mungbean, Phaseolus bean, cowpea, rice beans, horse gram, and pea are the major grain legume crops of Nepal (Figure 1). Separate statistics of mungbean are not available at present. However, it is estimated that approximately 12,000-hectare is under mungbean with an average annual production of 6,500 metric tons and an average yield of 0.5 t ha^{-1} (Joshi, Neupane and Bhujel, 1997)**.** The share of mungbean in area and production of grain legumes is only four percent. Consistent with the increasing trend in area and production of grain legumes in the country, similar observation is also observed in mungbean. More than 75 % mungbean area is mainly concentrated in the eastern and central *terai*, where there are more irrigated areas. The remaining 25 percent area falls in the western *terai* and foothills.

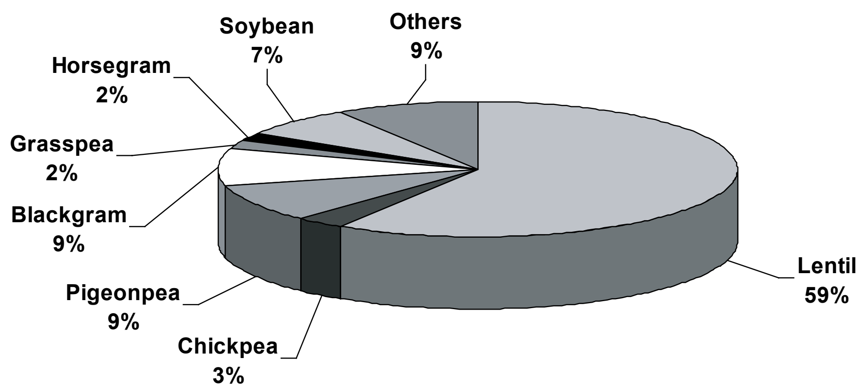

Figure 1. Percent share of grain legume production

The earlier recommended variety Pusa Baisakhi is susceptible to mungbean yellow mosaic virus (MYMV) and other foliar diseases, its seed size is smaller (2g/100 seeds), and it needs multiple picking (Bharati and Neupane, 1988). Recently, the Grain Legume Research Program has concentrated its efforts in identifying and selecting mungbean varieties resistant to MYMV. Collaborative efforts with AVRDC Taiwan have resulted in the selection of a number of genotypes with desirable attributes. These genotypes are being evaluated in farmer participatory trials and will be released in the near future.

Growing mungbean in Nepal will help alleviate poverty and raise farm income to some extent as outlined in the Long-Term Agriculture Perspective Plan (APP). In irrigated *terai* where rice-wheat is the pre-dominant cropping pattern, mungbean could be successfully grown as a catch crop or filler crop. Also, for the long-term sustainability of cereal-based cropping patterns, inclusion of short duration mungbean varieties into the system is one of the best options for farmers. The alternative systems (rice-wheat-mungbean, maize-mungbean-toria) seem possible provided we can have early maturing mungbean varieties with high yield, synchronized maturity, and resistance to CLS and MYMV diseases.

This paper deals with evaluation and selection of MYMV resistant, high yielding mungbean genotypes for maize and rice based systems of Nepal.

Importance and their Uses

The domestic production of mungbean falls short of demand and hence a large volume is imported from India. Mungbean is used in the following ways in Nepal:

- It is mainly consumed as a thick soup (*Dal*) prepared out of whole or split beans.
- It is used as medicine for diabetics, heart disease, and jaundice.
- Seeds are used to produce bean sprouts and ingredient for salad, soup or as a vegetable.
- The split mungbean is prepared as *bhujia* (fried and salted) which is a snack item in urban areas.
- Mungbean flour is used in making papar, unleavened bread, titaura (nuggets), etc.
- The crop is also utilized as fodder and green manure.

Cropping pattern

Mungbean is mainly grown in spring season just after the harvest of wheat and before transplanting rice in irrigated areas of *terai* (Bharati & Neupane, 1988). In rainy season during July to early August, it is grown on rice bunds to some extent. During July or early August, it is grown on the uplands of *terai* and on lower hills just after harvest of summer maize. It is also grown as an intercrop with maize to a limited scale. Though the cultivation is concentrated in the *terai*, it has good potential in warm valleys and river basin area. Due to the expansion of irrigation facilities in recent years and the declining fertility of cereal based system, there is a growing interest in short duration legumes like mungbean and huge demands for improved production technology.

Major constraints to production

Wide spread use of low yielding varieties, diseases [MYMV, CLS, powdery mildew, insect-pests (thrips, hairy caterpillars and sucking bugs)] are the major biotic constraints. Non-availability of seeds of improved varieties, poor agronomic management, inadequate extension services, and high cost of production due to the use of non-synchronous varieties are the major abiotic and socioeconomic constraints

Mungbean Research and Development

Goal

- To help raise the productivity and production of mungbean through identification, selection and recommendation of suitable varieties for the rice and/or maize based cropping system

Specific objective

- To develop high yielding and disease resistant mungbean varieties with synchronized maturity suitable for rice and maize based cropping systems.

Institutions involved in mungbean research and development in Nepal

To achieve the objectives, research in grain mungbean is coordinated by grain legumes research program (NGLRP) Rampur under Nepal Agricultural Research Council (NARC). Selected elite materials from screening nurseries and observation nurseries or international nurseries are evaluated in initial evaluation trials and then in multi-location yield trials in NARC stations across the country. Station proven varieties/technologies are evaluated in farmers' field through farmer participatory trials in collaboration with agriculture extension and other stakeholders as shown in the diagram below:

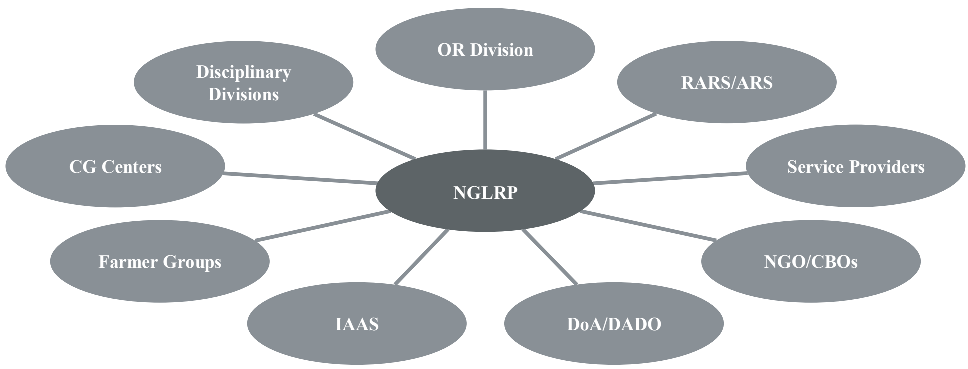

Figure 2. Institutions involved in R and D of mungbean

Research status

Research works in mungbean were initiated in 1973 and activities were limited to varietal, pathological and agronomical practices (NGLRP, 2001). Varietal improvement works have been continued with the objectives of identifying high yielding, uniform maturing and disease resistant cultivars adapted to *terai*, inner *terai* and mid hills conditions of Nepal. Pusa Baisakhi is the only improved variety of mungbean recommended in Nepal in 1979. Farmers in the *terai* are also growing various varieties PS 16, PS 7, Basanti, Narendra 1 and others released in India.

For the development of suitable varieties, NGLRP is actively engaged in screening of elite germplasm, selection and multi location testing of selected lines/genotypes, under rice- and maize-based system. The materials received through AVRDC-SAVERNET project as International Mungbean Nursery (IMN) and Asian Mungbean Varietal Trials (AMVT) have been promoted to farmer participatory trials and are in the process of release. Results of research conducted from 2000-2002 are summarized.

Results and Discussion

Mungbean yellow mosaic virus screening nursery

Sixteen mungbean genotypes were screened in 2000 and 2001 summer season at NGLRP, Rampur (Table 1). The incidence and severity of MYMV was more in 2001 than 2000. Three entries viz. VC 6368 (46-7-2), VC 6370 (30-65), and VC 6372 (45-8-1) were found completely free from MYMV infection in both years and rated as immune (Table 1). The other varieties were rated as resistant, moderately resistant, and tolerant. Local checks were found susceptible and the susceptible check was found highly susceptible. Other diseases such as CLS and *Rhizoctonia* blight were recorded. Besides disease resistance, these varieties have bold seed and high yield. Varieties VC 6369 (53-97), VC 6370-92, and VC 6370(21-15) were found resistant to MYMV at GLRP, Rampur and NORP, Sarlahi (Joshi et. al, 2000). Genotype VC 6372 (45-8-1) is a potential candidate for release in Nepal. The line VC 6372 (45-8-1) is also officially released in Bangladesh as BU 1 (AVRDC, 2001).

Table 1. Screening of mungbean varieties against MYMV at GLRP Rampur 2000 and 2001

Genotype	MYMV (0-5) Scale		Other disease (0 –5) Scale			
			CLS		RB	
	2000	2001	2000	2001	2000	2001
VC 3960A-88	0	2	1.5	1	1.0	1
VC 3960A-89	3	3	1.0	1	1.5	2
VC 6141-90	1	4	1.0	1	1.5	2
VC 6173A	2	3	1.0	1	1.5	2
VC 6173 C	0	3	1.0	1	1.5	2
VC 6368 (46-7-2)	0	0	1.0	1	1.5	2
VC 6368 (46-40-4)	2	2	2.0	2	1.5	2
VC 6369 (53-97)	0	3	1.0	1	1.5	2
VC 6370 (21-16)	3	4	1.5	2	1.0	1
VC 6370 (30-65)	0	0	1.5	2	1.0	1
VC 6370-92	0	2	2.0	2	1.5	1
VC 6371-94	0	4	1.0	1	2.0	2
VC 6372(45-8-1)	0	0	1.5	2	1.5	2
VC 1973A (CK)	5	5	1.0	1	1.0	1
Saptari local	4	4	1.0	1	1.0	1
Pusa Baisakhi	4	4	1.0	1	1.5	2

Note: MYMV incidence and scoring average of 3 replications

CLS = *Cercospora* leaf spot RB = *Rhizoctonia* blight

0 = no disease, 1 = resistant, 2 = moderated resistant, 3 = tolerant, 4 = moderately susceptible and 5 = susceptible.

AVRDC mungbean varietal trial

In mungbean varietal trial received from AVRDC, a total of 10 genotypes were evaluated at GLRP Rampur during summer 2000 /01 (Table 2). A RCB design with four replications was used. Significant difference was observed in the number of days to flower, plant height, pod length, 100 seed weight and seed yield. The genotype VC 6153B-20G produced the highest seed yield of 0.923 t ha^{-1} followed by VC 6173B-6 (0.782 t ha^{-1}), NM-92 (0.753 t ha^{-1}), VC 6372 (45-8-1) 0.737 t ha^{-1} and KPS 1 (0.711 t ha^{-1}) and these were at par. Seed size of VC 6173B-6, VC 6153B-20G and KPS1 was bigger (5 g 100^{-1} seeds) and attractive in appearance.

Table 2. Performance of selected mungbean genotypes in AVRDC varietal trial, Rampur 2000/01

Genotype	Days to flower	Days to mature	Plant height (cm)	Pod length (cm)	Pods $plant^{-1}$	Seeds pod^{-1}	100 seed wt. (g)	Grain yield (t ha^{-1})
VC 6153B-20G	27	48	56	10	31	10	5	0.923
VC 6173B-6	28	48	63	12	11	11	5	0.782
NM-92	25	48	53	9	8	11	2	0.753
VC 6372 (45-8-1)	25	48	62	10	12	11	2	0.737
KPS1	26	61	64	10	11	12	5	0.724
VC 6153-B-20P	28	47	71	11	36	12	3	0.711
Basanti	26	46	64	7	16	11	1	0.694
NM-54	26	47	73	11	9	12	3	0.685
VC 3960-88	25	47	56	9	10	14	3	0.659
Saptari local	28	46	68	8	12	12	2	0.496
Grand mean	27	49	67	9	15.7	11.8	3	0.632
F TEST	*	NS	**	**	NS	NS	**	**
$LSD_{(0.05)}$	2.89	-	11.5	0.99	-	-	1.11	0.21
CV%	7.41	11.94	12.05	7.14	9.8	8.43	24.4	22.9

* significant at 1% level, ** significant at 5% level, NS not significant at 5% level.

Similarly, in 2001/02, significant differences were noted among AVRDC materials in the number of days to maturity, pods $plant^{-1}$ and seed yield. The genotype VC 6372 (45-8-1) produced the highest yield (0.688 t ha^{-1}) followed by Basanti (0.640 t ha^{-1}) and BARImung (0.527 t ha^{-1}) while the check Saptari Local produced 0.130 t ha^{-1} (Table 3).

Table 3. Performance of selected mungbean genotypes in AVRDC Trial, NGLRP Rampur, 2001/02

Genotype	Days to mature	Pods plant^{-1}	Seeds pod^{-1}	Plant height (cm)	100 seed wt. (g)	Grain yield (t ha^{-1})	MYMV (No of plants affected)
VC 6372 (45-8-1)	56	7	9	8	3	0.688	0
Basanti	57	7	1	6	3	0.640	0
BARImung	62	4	11	7	3	0.527	2
Pusa 9072	61	4	12	7	3	0.516	0
ML 267	61	6	11	7	3	0.515	0
NM 92	56	5	10	8	3	0.513	0
Saptari Local	62	4	11	6	3	0.130	2
Mean	60	5	11	8	4	0.384	
$LSD_{(0.05)}$	1.15	1.06	0.87	0.67	0.30	0.15	
F Test	*	*	NS	NS	NS	*	
CV%	2.78	32.43	11.85	12.16	12.06	18.47	

* significant at 5% level, NS not significant at 5% level.

Coordinated varietal trial

Thirteen mungbean genotypes were planted at Rampur and Hardinath in a RCB design with four replications during 2000/01. The trial was planted after the harvest of wheat at Hardinath whereas at Rampur it was planted as a rainy season crop in maize-mungbean pattern in the 3rd week of July, 2000/01. Statistical analysis of grain yield showed significant differences among the genotypes in both years at Rampur (Table 4).

In 2001/02, the genotype VC 6372 (45-8-1) produced the highest seed yields of 1.01 t ha^{-1}, followed by VC 6153B-20G (0.975 t ha^{-1}), VC 6153-B-20P (0.876 t ha^{-1}) and VC 3960A-88 (0.804 t ha^{-1}) in Rampur. Similar results were obtained at Hardinath, though the yields were not significantly different (Table 5).

In 2002/2003, seventeen mungbean genotypes were tested in CVT at RARS Nepalgunj. Significant differences were observed in grain yield only. Nonetheless, among the tested genotypes, the highest grain yield was produced by the genotypes VC 6370-92 (0.541 t ha^{-1}) followed by VC 6369(53-79) (0.531t ha^{-1}) and ML 613 (0.510 t ha^{-1}) (Table 6).

Table 4. Performance of mungbean genotypes in coordinated varietal trial, NGLRP Rampur 2000/01

Genotype	Days to flower	Days to mature	Plant height (cm)	Pods plant^{-1}	Seeds pod^{-1}	100 seed weight (g)	Grain yield (t ha^{-1})
VC 3960A-88	38	59	35	11	11	4.1	0.564
NMB101	38	61	42	13	11	5.1	0.549
NM 92	38	63	36	11	12	4.5	0.542
VC 6173B-6	37	61	34	11	12	3.6	0.535
VC 6150B-20A	40	62	35	11	12	5.0	0.525
NM 54	40	62	34	13	12	5.1	0.510
ML-613	37	61	38	11	12	5.6	0.505
VC 6153B-20G	38	61	37	12	12	6.2	0.504
Saptari local	38	58	36	13	11	2.1	0.395
Grand mean	38.9	60.6	37	12	12	4.2	0.482
F test	NS	NS	NS	NS	NS	NS	*
LSD $_{(0.05)}$	-	-	-	-	-		0.103
CV %	5.26	10.02	15.08	20.25	8.43		14.97

* significant at 5%, ** significant at 1%, NS not significant at 5%

Table 5. Performance of mungbean genotypes in coordinated trial at NGLRP Rampur and NRRP Hardinath, 2001/02

Genotype	Days to Mature	Plant height (cm)	Pods plant^{-1}	Seeds pod^{-1}	Pod length (cm)	100 seed weight (g)	Grain yield (t ha^{-1}) Rampur	Grain yield (t ha^{-1}) (NRRP) Hardinath	MYMV (No of plants affected)
VC 6372 (45-8-1)	55	78	6	10	10	4	1.010	0.916	0
VC 6153B-20G	55	62	7	10	10	6	0.975	0.697	2
VC 6153-B-20P	56	72	5	11	10	5	0.876	0.981	0
VC 3960A-88	55	69	9	9	8	4	0.804	0.761	2
VC 6370-92	55	59	7	9	9	5	0.769	0.875	2
NM 92	55	71	6	9	9	5	0.756	0.695	0
NM 54	57	70	6	10	9	4	0.729	0.963	2
KPS #1	62	70	4	12	9	4	0.679	0.412	45
Saptari local	58	66	7	11	7	2	0.466	0.448	4
Pusa Baisakhi	59	66	4	10	7	2	0.254	0.506	0
Mean n=	58	68	6	10	8	4	0.644	0.699	
LSD $_{(0.05)}$	1.62	7.82	0.59	0.65	0.60	0.29	0.18	0.53	
F Test	**	*	*	**	**	**	*	NS	
CV%	4.02	16.44	14.61	8.97	10.35	11.09	19.83	36.8	

* significant at 5% level, ** significant at 1% level, NS not signifcant at 5% level

Table 6. Performance of mungbean genotypes in coordinated varietal trial on mungbean at Nepalgunj, 2002

Variety	Days to flower	Days to mature	Plant height (cm)	Pods plant^{-1}	Seeds pod^{-1}	Grain yield (t ha^{-1})	1000 seed weight (g)
VC 6370-92	47	68	45	16	7	0.541	49
VC 6369 (53-79)	45	72	47	17	8	0.531	43
ML 267	44	71	48	15	8	0.510	36
ML 613	47	72	50	9	8	0.510	48
VC 6141-90	44	71	42	12	8	0.500	42
VC 6372 (45-8-1)	43	72	44	17	7	0.479	40
VC 3960A-88	44	68	45	20	8	0.479	43
VC 6370 (30-65)	47	73	49	19	8	0.479	47
VC 6153-B-20p	46	70	53	9	9	0.468	50
NM-54	46	68	49	13	8	0.458	38
BARImung	47	71	56	18	8	0.416	38
Saptari local	49	72	50	22	9	0.401	38
NM-92	43	70	54	18	7	0.374	43
NMB 101	47	73	45	20	8	0.374	45
Pusa Baisakhi	52	70	43	14	7	0.322	42
VC 6153B-20G	43	67	46	11	8	0.228	46
VC 6173B-6	45	73	50	18	7	0.208	49
Mean	45	71	48	16	8	0.428	43
CV%	8.96	3.8	11.52	43.13	8.3	34.9	19.06
F Test	NS	NS	NS	NS	NS	*	NS
LSD $_{(0.05)}$	6.77	4.48	9.27	11.57	2.43	0.25	13.85

** significant at 1% level, * significant at 5% level, NS not significant at 5% level

In CVT conducted at NGLRP Rampur during 2002/03, significant differences were found among the genotypes in the yield attributing traits. The highest grain yield was obtained from VC 6372 (45-8-1) (0.853 t ha^{-1}) followed by VC 6153B-20G (0.838 t ha^{-1}) VC 6370-92 (0.836 t ha^{-1}) & NM 92 (0.826 t ha^{-1}) whereas the check variety Saptari Local & Pusa Baisakhi produced only 0.344 and 0.599 t ha^{-1} respectively (Table 7).

Table 7. Performance of mungbean genotypes in coordinated varietal trial at Rampur, 2002

Variety	Days to flower	Days to mature	Plant height (cm)	Pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	Grain Yield (t ha^{-1})	100 seed weight (g)
VC 6372 (45-8-1)	39	53	67	16	8	11	0.853	5.0
VC 6153B-20G	40	54	51	14	9	10	0.838	6.0
VC 6370-92	40	53	62	17	9	9	0.836	5.0
NM-92	41	54	60	18	8	11	0.826	4.6
NMB 101	41	54	59	18	9	11	0.644	4.3
VC 6141-90	42	57	69	17	8	11	0.639	4.3
VC 3960A-88	40	55	64	22	8	11	0.624	4.3
NM-54	42	58	69	14	8	10	0.619	5.0
VC 6370 (30-65)	41	54	61	14	9	11	0.602	5.0
Pusa Baisakhi	42	57	64	20	7	12	0.599	3.6
ML 613	43	55	59	14	9	11	0.582	5.6
ML 267	43	57	69	16	7	10	0.563	3.0
VC 6173B-6	42	58	71	16	8	11	0.525	4.0
VC 6369 (53-79)	40	54	55	17	8	11	0.502	5.0
VC 6153-B-20p	41	57	67	12	9	10	0.491	5.3
BARImung	43	58	72	18	8	10	0.463	4.0
Saptari local	42	57	62	16	8	10	0.344	3.3
Mean	41	56	64	16	8	10	0.609	4.5
CV%	2.18	2.38	9.18	17.4	8.15	7.16	17.68	8.3
F Test	**	**	**	*	*	**	**	**
LSD $_{(0.05)}$	1.51	2.21	9.83	4.84	1.17	1.29	0.18	0.63

* significant at 1% level, ** significant at 5% level.

Participatory varietal selection trial (PVS)

At present, outreach research on grain legumes is being conducted through ARSs/ RARSs in their command districts. Each ARS/RARS is mandated to conduct outreach research based on the farmer perceived problems in its command districts. In collaboration with ARSs/RARSs, grain legume varieties/technologies are evaluated as PVS/PPVS/CFFTs/FATs in their command areas, and feedback is obtained from the stations. PVS, FFTs and FATs on grain legumes are also evaluated in collaboration with NGOs, farmer groups, ADOs as per mutual need and understanding of both parties.

NGLRP is also directly involved in farmers' participatory on-farm research on mungbean and other legumes. Under this program are activities related to the testing, verification and dissemination of technological packages for higher production in farmers' field of Nepal.

To evaluate the performance of mungbean genotypes during 2001, a PVS was conducted in farmer's field of Manahari (Makwanpur district). Each genotype of mungbean was tested in 20-m^2 plots using a RCB design and replicated five times. The field was fertilized with DAP, MOP and urea by maintaining the fertilizer dose of N: P_2O_5: K_2O: 20:40:20 kg ha^{-1}. Other cultivation practices and management were done as per farmers practice. Seeds were sown at 25 kg ha^{-1} by maintaining the crop geometry of 40 × 10 cm. Data on grain yield was recorded at maturity and subjected to statistical analysis.

There was no significant difference among the genotypes in grain yield. However, the genotype VC 6173B–6 produced the highest yield (0.51 t ha^{-1}) compared to the rest. Farmers preferred VC 6372 (45-8-1), because of its bold seed size and absence of MYMV (Figure 1).

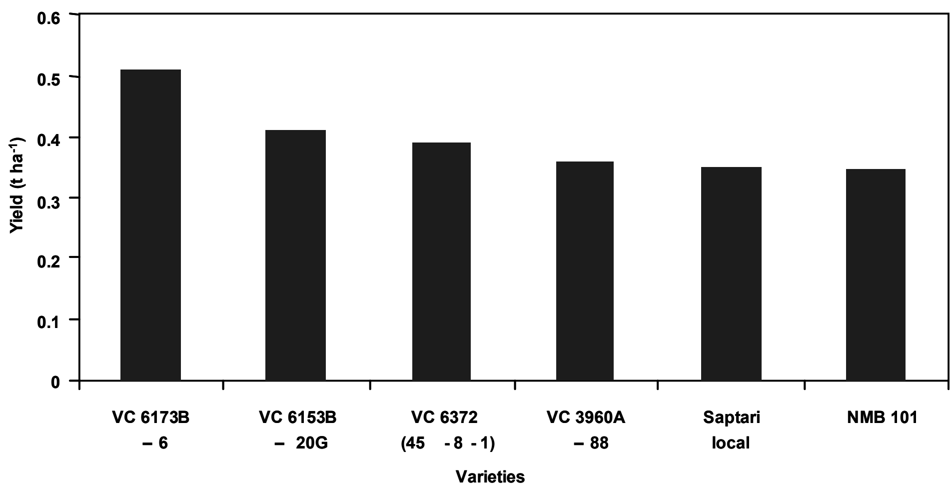

Figure 1. Seed yield of mungbean genotypes in PVS Manahari 2001/02

From the above results, it was clear that genotypes VC 6369 (53-97), VC 6370 (30-65), VC 3960 A-88, VC 6173 C, VC 6368 (46-7-2), VC 6370-92, VC 6371-94 are resistant to MYMV, possess attractive bold seeds, and mature within 60-70 days. These genotypes are erect, determinate, photoperiod insensitive, and widely adapted. These also have potential to grow in rain fed uplands as a summer crop in inner *terai* and river basin areas.

Field monitoring of FORWARD implemented trials

From monitoring tour to FORWARD commanded areas of eastern (Jhapa, Morang and Sunsari districts), mid (Makawanpur district) and western (Kapilbastu district) *terai*, it was found that heavy infestation of thrips, sucking bucks, hairy caterpillar and painted bug enormously reduced the yield (upto 100% yield reduction in non sprayed plots). On the contrary, incidence of MYMV was negligible (<1 score in 1 to 5 scale). In all the areas newly introduced genotypes viz. VC 6372 (45-8-1), NM 92 and NM 94 showed better performance with respect to yield attributing characters, maturity, insect and disease incidence compared to local check. Moreover, the selected genotypes have bold grain, good pod set, early maturity, less pest problem, and tasty to eat characteristics. Farmers were willing to save the seed and increase the area in the next year

Conclusion

- The genotypes VC 3960A-88, VC 6173C, VC 6372 (45-8-1), VC 6371-94, VC 6371-92, VC 6368 (46-7-2) were resistant to MYMV.
- In mungbean trial involving genotypes from the AVRDC, the genotypes VC 6372 (45-8-1), VC 3960A-88, VC 6153 B-20G, and VC 6153 B-20P were found high yielding at Rampur. VC 6173B-6, VC 6153B-20G, KPS1 and CN9-5 were identified as bold seeded genotypes, i.e. (5g 100^{-1} seeds) and attractive in appearance.
- In coordinated varietal trial, the genotypes VC 3960A-88, VC 6372 (45-8-1), VC 6368 (46-7-2), VC 6153 B-20 G produced higher yields than the check varieties Pusa Baisakhi and Saptari local in both years.
- Genotypes VC 3960A-88, VC 6372 (45-8-1), VC 6368 (46-7-2), VC 6153 B-20 have attractive bold seeds and are being promoted for participatory varietal selection (PVS) trial. These genotypes are the potential candidates for release.
- In PVS 2001, farmers highly appreciated and preferred VC 6372 (45-8-1) because of its bold seed size and absence of MYMV.

Future strategy

Immediate/short term strategy

- Obtain segregating materials from IARCs, and evaluate, select and recommend mungbean varieties.
- Collect, evaluate and select suitable varieties from local materials.
- Identify sources of resistance for major diseases and pests of mungbean.
- Verify the on-station proven technology in farmer's field through farmer participatory research and recommend it.

Long term

- Initiate breeding for resistance to major biotic constraints of mungbean.
- Collaborate with IARCs for collaborative breeding.
- Research on integrated pest and disease management for major insect pests and diseases.
- Research on integrated nutrient management system through inclusion of mungbean in the cropping pattern.
- Fine tuning the agronomic management practices for major production systems.
- Research on post- harvest, handling, drying, threshing, storage and utilization of mungbean.
- Develop appropriate low cost technology for higher yield.
- Seed production.
- Collaborative research on grain legumes with other research organizations in Nepal.

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