# PULSES

## INTRODUCTION

Pulses are the most important source of vegetable protein in Pakistan. They are cultivated on 5% of the total cropped area. Their use ranges from baby food to delicacies of the rich and the poor. Because of the population growth, demand for pulses is increasing day by day. There is a need to develop varieties with higher yield potential that respond to improved management practices so as to meet the increasing demand of pulses.

Major pulse crops grown in the country are chickpea (Cicer arietinum L.), lentil (Lens culinaris Medic.), mung bean (Vigna radiata (L.) Wilczek), black gram or mash (Vigna mungo L. Hepper) and khesari (Lathyrus sativus L.). There are other summer and winter pulses such as pigeonpea (Cajanus cajan L. Millsp.), Cowpea (Vigna unguiculata (L.) Walp.), moth bean (Vigna aconitifolia (Jack) Merechal), common beans (Phaseolus vulgaris L.) and faba bean (Vicia faba L.). These minor pulses are grown on small areas.

The total area under major pulse crops in Pakistan is about 1.5m hectares. Among these pulses, chickpea is the major winter food legume and mung is the major summer legume. Chickpea occupies 73% of the total pulses area with 76% contribution to the total production, whereas mung bean occupies 18% of total area devoted to pulses contributing 16% to the total pulses production. The black gram and lentil, each are cultivated on 5% of the total pulses area and each of them contributes 5% to the total pulses production.

## OBJECTIVES

- To develop varieties of chickpea (Cicer arietinum), lentil (Lens culinaris), mungbean (Vigna radiata) and blackgram (Vigna mungo), through breeding, molecular techniques and selection.
- To develop varieties responsive to high inputs, e.g., irrigation, fertilizers and Rhizobium inoculation.
- To develop disease, drought, cold and herbicide resistance in pulse crops.
- To enhance genetic variation in pulses germplasm.
- To develop and introduce appropriate production technology including seed rate, planting time, fertilizer application, weed control strategies among the farmers for increased production.

## CHICKPEA

Chickpea has been the focus of research since the inception of systematic research work on pulses in Pakistan. Major importance to chickpea improvement was attributed because it contributes 70-80% to the total pulses area and production. The Thal desert that can not support/sustain major cash crops due to low fertility and lack of artificial irrigation is well known as home of chickpea. This is because chickpea can perform well under conditions of moisture stress in marginal soils. The drought tolerance in this crop is extremely desirable attribute for moisture deficient areas of the country. The medium fertility, moderate moisture levels, sandy loam soils and moderate winters provide optimum conditions for chickpea cultivation. The study of the production profile reveals swear fluctuation highlighting the problem of instability, which may be attributed to 3 major constraints. Drought or moisture stress and wilt are the twin problems that occur together. The third major constraint to chickpea production is

Ascochyta blight. The major emphasis was placed on these issues and consequently various institutes released 10 blight resistant varieties of Desi chickpea. By the release of these varieties, chickpea captured more area in Potohar; chickpea area had reduced to minimal level. Keeping these priorities into consideration, pulses programme, NARC, Islamabad is engaged in multidisciplinary research to develop blight resistant genotypes of Kabuli chickpea that have high yield potential. Breeding of Desi chickpea with emphasis on development of varieties with multiple resistances against disease and with drought resistance is in progress. At present, 5 candidate lines of Desi chickpea and 5 of Kabuli developed by NARC are in national yield testing programme.

**DISEASE RESISTANT HIGH YIELDING VARIETIES FOR POTOHAR AREA.**

Chickpea blight caused by Ascochyta rabiei has been a major disease constraining chickpea production in the country. This problem caused total crop failure in the early nineties. Potohar area that has been traditionally a chickpea growing area has become a hot spot for this disease. Progressively the area of chickpea in Potohar reduced drastically. Realizing the gravity of the problem Pulses program NARC initiated a breeding program aimed at development of blight resistant varieties of chickpea. Pulses Programme, NARC released two high yielding disease resistant varieties during 2003 to replace blight susceptible cultivars.

**VARIETIES DEVELOPED (DASHT AND PARBAT)**
**Salient features**

- These varieties possess a good level of resistance against blight.
- Both varieties have displayed resistance against multiple isolates of blight pathogen.
- Both are tolerant to cold.
- Both varieties are resistant to iron chlorosis.
- Their seed quality parameters are comparable with those of released varieties.
- Yield potential of both cultivars is 1500-2000 kg/ha on farmer's field.
- 1st October to 15 November is the optimum sowing time for these varieties in Potohar.
- 25-30 kg/acre seed rate is recommended for better harvest for these varieties.
- Seed treatment with Benlate @ 2g/kg seed is recommended for the eradication of primary inoculums on seed

**Dasht and Parbat growing side by side in Potohar**

**CANDIDATE VARIETIES**

| S. NO. | DESI | KABULI |
|---|---|---|
| 1 | CMC211S | NCS 0530 |

| | | |
|---|---|---|
| 2 | NCS 9917 | NCS 0608 |
| 3 | NCS 0506 | NCS-0523 |
| 4 | NCS 0605 | NCS 0505 |
| 5 | NCS 0601 | NCS-0618 |

**LENTIL**

**Markaz-09, a new high yielding, lodging and multiple disease resistant lentil variety for the plains, foothills and Pothwar areas of Pakistan**

Lentil is the second major Rabi pulse crop after chickpea in Pakistan. So far, only nine lentil varieties are released in the country. It indicates an insufficient research work on lentil in the country. It is essential that variety development and release process should never be stopped or interrupted to replace and/or complement the old varieties and having sufficient genetic diversity in the farmer's field to avoid any disease vulnerability of the genetic material. At the same time, increased seed yield is essential to meet the present and future demands of ever increasing population of the country. Realizing significance of all these factors, Markaz-09 was developed by Pulses Program at NARC through hybridization process and recombined all desirable traits into one genetic background. The proposal for its release was submitted in the Punjab Seed Council. The committee of the council conducted the spot examination on March 24, 2009 and recommended it. After that, in its 60th Sub-Committee Meeting held on May 15, 2009 at Ayub Agricultural Research Institute, Faisalabad, the variety was approved and recommended for its cultivation in the target areas.

The variety, Markaz-09, has been developed for the barani and irrigated areas falling in the plains and Pothwar region or relatively less cold areas of Pakistan and all those traits are recombined in this genotype that needed for its sustainability in the recommended areas of the country. In the plains, besides drought tolerance, rust and Ascochyta blight resistance are essential traits for the genotypes to survive. Furthermore, presently no lentil variety is lodging resistant due to their soft stem structure. Other desirable traits are linked with the consumer preference and marketing. Anyway, besides high yield and drought tolerance, lodging resistant, bold-seeded micro-sperma, red cotyledon colour, black-spotted testa, free from hard-seededness, high protein content and good taste are the most desirable traits for the variety. All these traits are recombined into Markaz-09. It has shown promise for farmer acceptance when tested at different locations in the country.

Markaz-09 has substantial improvement over check varieties (Masoor-93 & Masoo-06) in terms of seed yield (121-135%), resistance to major diseases particularly to Ascochyta blight and rust, seed size (0-25%), reduced cooking time (5-10%) and tannin (9-20%). The variety gave over 1.8 t/ha average seed yield as compared to 0.8 t/ha by the check varieties. Apart from its high yield at all levels, significantly reduced cooking time indicated its being free from any hard seeds, which is highly important character for consumer preference. The variety has the yield potential of 3.2 t/ha.


***Vigorous growth and heavy podding of Markaz-09. The branches devoid of leaves and still green at maturity***
***(right picture) indicating drought tolerance characteristic of the variety.***

***Spot examination of the variety, Markaz-09 conducted by the Expert Sub-committee of Punjab Seed Council on March 24, 2009 at NARC, Islamabad.***

**MUNGBEAN**

Mungbean is one of the important kharif pulses of Pakistan. It is also grown during spring season mainly in southern Punjab and Sindh province. Punjab is the major mungbean growing province that alone accounted for 88% area and 85% of the total mungbean production. Cultivation is concentrated in the districts of Layyah, Bhakkar, Mainwali and Rawalpindi. It is mainly grown in Kharif season (July October). Although it is grown in different crop rotations, about 75% cultivation follows mungbean - wheat crop rotation. The breeding improvement of mungbean had been limited until 1970 due to the selection from land races which were of trailing types. Research on this crop like other pulses gained momentum form 1980 when Coordinated Pulses Research Program was started at federal level by PARC in collaboration with provincial research institutes. This program, through generation of funds, short term and long-term trainings, exchange of germplasm/research material with National and International Research Institutes

and evaluation of new improved lines, strengthened research on pulses. From 1985-86 to date about ten improved varieties have been released for general cultivation in the country. With the development of short duration and uniform maturing varieties, mungbean can be fitted in various cropping systems. Among the major constraints weeds, insect damage and lack of seed production are the most important ones. Research activities on mungbean have mainly been focused on the development of high yielding varieties with wider adaptability, resistant to diseases like mungbean yellow mosaic virus (MYMV) and Cercospora leaf spot (CLS), early maturity and insensitivity to photo period.

**CANDIDATE LINES**

1. NCM-209
2. NCM-257-2
3. NCM-252-7

**MASH**

Mash or black gram [Vigna mungo (L.) Hepper] belongs to family Leguminosae. Mash occupies an important position in Pakistan's agriculture. It grows on marginal land where other crops perform poorly. Being leguminous, it demands less nitrogenous fertilizer, and fits well as source of protein (25-32%). The worldwide yield of mash (including Pakistan) is very low because mostly indigenous land races are cultivated and also because the crop is often grown on marginally fertile land with insufficient water. In Pakistan, mash is the least researched crop among pulses despite its high nutritive and economic value due to which its area and production decreased continuously. The lack of suitable and high-yielding varieties and basic information about production technology are major inhibitors. Therefore, research on mash improvement aims at development of high yielding varieties with resistance to diseases (MYMV & CLS).

**VARIETIES DEVELOPED (NARC MASH-1, NARC MASH-2 AND NARC MASH-3)**

**NARC Mash - 1**

- Year of release 1993
- Duration 80 - 85 days
- Plant type Glabrous and semi erect
- Disease reaction Resistant to Yellow Mosaic Virus
- Cultivation areas Islamabad, Rawalpindi, Sialkot, Narowal, Gujrat & NWFP
- Yield potential on farmers' fields 1500 - 2000 Kg/Ha

**NARC Mash - 2**

- Year of release 1993
- Duration 70 - 75 days
- Plant type Semi erect
- Disease reaction Resistant toYellow Mosaic Virus
- Cultivation areas Islamabad, Rawalpindi, Sialkot, Narowal, Gujrat & NWFP
- Yield potential on farmers' fields 1500 - 2000 Kg/ Ha

**NARC Mash - 3**

- Year of release 1993
- Duration 60 - 65 days
- Plant type Erect
- Disease reaction Resistant toYellow Mosaic Virus
- Cultivation areas Islamabad, Rawalpindi, Dir, Chitral, Mansehra, Swat and AJK
- Yield potential on farmers' fields 1000 - 1500 Kg/ Ha

**CANDIDATE LINES**

1. 9092
2. VH9440034-1
3. VH9440023-2
4. VH9440039-8

**PULSES AGRONOMY**

Nodulation capability studies on chickpea, lentil and mung.

High and effective nodulation on the roots of the pulse crops is an important agronomic factor. This trait can be exploited in the breeding programs of the pulses to develop genotypes with high nodulation and consequently with higher yields. A fair amount of costly fertilizer can be saved in this way. Nearly 35 promising genotypes of chickpea, lentil and mungbean have been screened for their nodulation behavior.

**Plant density/population studies on lentil and chickpea**

Optimum seed rate in pulses is the most important factor for realizing good yields. It has been observed that farmers still use lesser seed rates especially in chickpea and lentil. Experiments on seeding density have been carried out at NARC on promising and commercial varieties of lentil and chickpea. As a result of studies;

- Sowing rate for lentil was optimized as 45kg/ha.
- Optimum plant population for better yield in chickpea was identified as 0.67m plants/ha.

***Nutrient management studies***

Fertilization with P, Zn and B for chickpea, with P and B for mash and with Zn for mungbean has been found beneficial.

***Rhizobium x fungicide interaction in chickpea and lentil***

Nodulation and yield improved with simultaneous application of Rhizobium and seed dressing fungicide "Benlate" over seed treatment with benlate only.

**Planting time for mungbean**

Sowing time of mungbean has been controvercial for many reasons especially in its growing areas. Experiment carried out at NARC revealed that 1st two weeks of July is better sowing time for mungbean under rainfed conditions.

**PULSES PATHOLOGY**

Identification of resistant mungbean and mashbean genotypes against Cecospora leaf spot for incorporating in breeding programme to develop disease resistant varieties

Fifty-eight mungbean genotypes were evaluated for resistance against Cercospora leaf spot disease under artificially inoculated disease condition in the field. There was a considerable variation among the genotypes with respect to disease reaction. Disease score of the genotypes ranged from "1-5". Twelve genotypes; NM-98, 98-cmg-003, C2/94-4-42, NM-1, NM-2, 98cmg-018, BRM-188, CO-3, Basanti, PDM-11, BARI Mung-2 and VC3960-88 with disease score "1" were found highly resistant and 15 with disease score "2' showed resistant reaction against the disease, while 17 revealed the moderately resistant (tolerance) reaction. Rest of the genotypes with disease rating "4-5" was either susceptible or highly susceptible.

**Evaluation of chickpea national and international Ascochyta blight screening nurseries**

Three hundred and fifty five chickpea germplasm accessions were evaluated for blight resistance under greenhouse conditions during the Rabi season of 2005-06. The results revealed that fifteen genotypes with disease rating score 3 were resistant, 81 genotypes with disease rating score 4-5 were moderately resistant and 259 were susceptible. Most of the resistant genotypes were developed at International Center Agricultural Research in Dry Areas and National Agricultural Research Center, Islamabad.

Biological pathotypes of various A. rabiei isolates using a set of cultivars and grouping of isolates on the basis of their virulence

Fourteen isolates of Ascochyta rabiei derived from single spore cultures representing 14 collecting sites of Pakistan were studied for morphological characters and disease development on ten chickpea

varieties. The isolates exhibited variation for morphological and cultural characteristics. AR-10 was the most virulent isolate whereas AR-1 was the least virulent isolate. On the contrary, the AR-1 was the fastest growing and AR-12 was the slowest growing isolate. There was a variation among chickpea genotypes for blight. Punjab-91 was susceptible to all the isolates where as the remaining cultivars acted as differentials and showed considerable variation in disease development with different isolates. The varieties, Pujab-91, C-44, Piadar and ILC-263 revealed high degree of susceptibility. The differentials were identified in chickpea genotypes but no variety could be tolerant/ resistant against all the isolates. It might be due to complex nature of A. rabiei. The situation suggests modifying chickpea breeding for blight resistance as to use multiple crosses to build resistance pyramids involving parents with known level of tolerance.

**Screening of chickpea germplasm against Fusarium wilt to identify resistant sources**

158 chickpea lines/genotypes were evaluated for resistance against wilt under artificial disease condition in the field. There was a considerable variation among these genotypes with respect to their disease reaction. At the later stage when the crop was near to maturity, four genotypes with 0-8.3% disease were resistant and 4 with 11-20% rated as tolerant while the rest 150 were susceptible. At the seedling stage most of the genotypes were resistant and only 22 were susceptible. The disease symptoms initiated 30 days after sowing. It was observed that there was more incidence of disease at seedling stage than the later stage.

Identification of resistant lentil genotypes against blight for incorporating in breeding programme to develop blight resistant lentil varieties

Seventy five lentil germplasm accessions, obtained from exotic and local sources were evaluated under greenhouse conditions at National Agricultural Research Centre, Islamabad against a virulent isolate of Ascochyta lentis originated from Pakistan. Variability in disease reaction was observed among genotypes. Most of the lines from Pakistan and Syria were susceptible to blight. Only three lines (UJL 129, PI 299127 and Precoz) were found resistant and 25 were moderately resistant to Ascochyta blight. This study reported some additional sources of resistance in world collection of lentil germplasm against a virulent isolate of A. lentis from Pakistan.

**Fungicides used for the determination of variability in Fusarium oxysporum f.sp. ciceri.**
Variability among the isolates of F. oxysporum was also determined on the basis of sensitivity of isolates to different fungicides. It was observed that there was a significant variability in this regard. Benlate was found to be the most effective in suppressing the growth of all the test isolates. It was followed by Ridomil and Sancozeb with respect to efficacy. Captan and PCNB were the least effective while Trimiltox forte, Antracol, Dithane M-45 and Copper oxychloride exhibited intermediate response in efficacy.

**Chickpea, lentil, Mung bean and Mash varieties released in Pakistan through NARS up to 2010**

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|---|---|---|---|---|
| **Chickpea** | CM-72 | NIAB, Faisalabad | 1982 | Desi, high yielding, small seeded, tolerant to Ascochyta blight. |
| | C-44 | AARI, Faisalabad | 1982 | Desi, high yielding, bold seeded, tolerant to A blight, susceptible to iron chlorosis. |

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| | Noor-91 | AARI, Faisalabad | 1992 | Kabuli, high yielding, bold seeded, tolerant to A blight. |
| | Punjab-91 | AARI, Faisalabad | 1992 | Desi, high yielding, bold seeded, tolerant to A. blight, in case of delayed maturity susceptible to shattering. |
| | Paidar-91 | AARI, Faisalabad | 1992 | Desi, high yielding, medium seeded, tolerant to ascochyta blight. |
| | NIFA-88 | NIFA, Peshawar | 1992 | Desi, high yielding, small seeded, tolerant to ascochyta blight. |
| | DG-89 | RRI, Dokri, Sindh | 1989 | Desi, medium bold seeded, high yielding, suitable for rice based system of Sindh, tolerant to root diseases. |
| | DG-92 | RRI, Dokri, Sindh | 1989 | Kabuli, high yielding and suitable for rice based system of Sindh, province. |
| | Karak-1 | GRS, Karak | 1992 | Desi, small seeded, drought tolerant, tolerant to blight. |
| | Bittle-98 | AARI, Faisalabad | 1998 | Desi, high yielding, bold seeded, tolerant to A blight resistant to iron chlorosis. |
| | KC-98 | GRS, Karak | 1998 | Kabuli, tolerant to blight and drought, high yielding |
| | Sheenghar | GRS, Karak | 2000 | Drought and blight tolerant, bold seeded, high yielding |
| | Lawagar | GRS, Karak | 2000 | Kabuli, medium bold seeded, drought and wilt tolerant. |
| | Punjab-2000 | AARI, Faisalabad | 2000 | Desi, high yielding, bold seeded, A. blight tolerant, resistant to shattering. |
| | CM-2000 | NIAB, Faisalabad | 2000 | Kabuli, high yielding, med seeded, tolerant to A. blight, suitable for in irrigated and rice growing areas. |
| | Balkasar | BARI, Chakwal | 2000 | Desi, high yielding, medium seeded, tolerant to A. blight, suitable for cultivation in Pothwar region. |

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| | Venhar | BARI, Chakwal | 2000 | Desi, high yielding, medium seeded, tolerant to A blight, suitable for cultivation in Pothwar region. |
| | Dashat | NARC, Islamabad | 2003 | Desi, high yielding, medium seeded, resistant to ascochyta blight, suitable for cultivation in Pothwar region. |
| | Parbat | NARC, Islamabad | 2003 | Desi, high yielder than Dasht medium seeded, resistant to A. blight, suitable for cultivation in Pothwar region. |
| | KK-2 | GRS, Karak | 2003 | Desi, drought tolerant, med. seed size |
| | KK-3 | GRS, Karak | 2003 | |
| | Thal-2006 | AZRI, Bhakkar | 2006 | Bold seeded, drought and blight tolerant, highly responsive to irrigation. |
| | CM-2008 | NIAB, Faisalabad | 2008 | Kabuli, high yielding, mutant |
| | Punjab-2008 | AARI, Faisalabad | 2008 | Desi, high yielding |
| | Punjab Noor-2009 | AARI, Faisalabad | 2009 | Kabuli, high yielding, tolerant to *Fusarium* wilt, suitable for cultivation in irrigated areas. |
| **Lentil** | Masoor 85 | AARI, Faisalabad | 1985 | Small seeded, high yielding, resistant to Ascochyta blight and rust, pink cotyledons tolerant to collar rot. |
| | Mansehra-89 | ARS, Dhudial, NWFP | 1989 | Bold seeded, early maturing, high yielding resistant to Ascochyta blight and rust, yellow cotyledons. |
| | Masoor-93 | AARI, Faisalabad | 1993 | Medium seeded, high yielding, resistant to Ascochyta blight and rust, pink cotyledons. |
| | Shiraz-96 | AZRC, PARC, Quetta | 1996 | Cold & drought tolerant high yielding bold seeded, red cotyledon. Suitable for cultivation in high lands. |
| | Masoor-2002 | NIAB, Faisalabad | 2002 | Short duration, bold seeded, black spotted testa, suitable for cultivation in post-cotton environment. |

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|---|---|---|---|---|
| | Masoor-2004 | ARI, D.I. Khan | 2004 | Fit for rice based system, spotted testa, microsprema. |
| | RK-2004 | ARI, D.I. Khan | 2004 | Drought tolerant, spotted testa, microsprema |
| | NIA Masoor-05 | NIA, Tandojam | 2005 | |
| | NIAB Masoor 2006 | NIAB, Faisalabad | 2006 | Suitable for lentil growing areas of Punjab, black spotted, red cotyledon, med. maturity, mutant of ICARDA line |
| | Markaz-09 | NARC, Islamabad | 2009 | Suitable for barani and irrigated areas of the plains and Pothwar region. High yielding, drought tol., lodging resistant. |
| | Punjab Masoor | AARI, Faisalabad | 2009 | High yielding, moderately resistant to rust and stem rot, tolerant to lodging |
| **Mung** | NM-121-25 | NIAB, Faisalabad | 1985 | |
| | NM-20-21 | NIAB, Faisalabad | 1985 | |
| | NM-51 | NIAB, Faisalabad | 1991 | Early, bold seeded, dull seed color, tolerant to cercospora leaf spot. |
| | NM-54 | NIAB, Faisalabad | 1991 | Early, bold seeded, dull seed color, tolerant to cercospora leaf spot. |
| | NM-92 | NIAB, Faisalabad | 1993 | Early, bold seeded, shiy color, tolerant to cercospora leaf spot(CLV) and yellow mosaic virus (YMV). |
| | AEM-96 | NIA, Tandojam | 1997 | Small seeded, shiny green colour resistant to CLV and YMV. Suitable for cultivation in Sindh Province. |
| | NM-98 | NIAB, Faisalabad | 1998 | Medium bold seeded, high yielding and yellow mosaic tolerant. |
| | Chakwal Mung-97 | BARI, Chakwal | 2000 | Small seeded, shiny green colour, resistant to CLV and YMV. Suitable for cultivation in Pothwar region. |
| | Karak Mung-1 | ARS, Karak | | |

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|---|---|---|---|---|
| | Ramzan-2005 | NIFA, Peshawar | 2005 | High yielding, drought and MYMV tolerant. |
| | NM-2006 | NIAB, Faisalabad | 2006 | Bold seeded, high yielding and MYMV tolerant. |
| | Chakwal Mung-2006 | BARI, Chakwal | 2006 | High yielding, drought tolerant and MYMV tolerant. |
| | AZRI Mung-06 | AZRI, Bhakkar | 2006 | Bold seeded, non-shattering, short duration, disease tolerant, high yielding |
| | Dera Mung | PARC Pulses Prog. ARI, D.I.Khan | 2008 | Southern Districts of NWFP |
| **Moth** | Dera Moth | PARC Pulses Prog. ARI, D.I.Khan | 2008 | Southern Districts of NWFP |
| | Green Moth | PARC Pulses Prog.. ARI, D.I.Khan | 2008 | Southern Districts of NWFP |
| **Mash** | Mash-48 | AARI, Faisalabad | | |
| | Mash-80 | AARI, Faisalabad | | |
| | Mash-88 | AARI, Faisalabad | 1988 | Medium maturity, semi-erect |
| | Mash-1 | NARC, Islamabad | 1993 | Medium maturity, semi-erect, high yielding, tolerant to MYMV. |
| | Mash-2 | NARC, Islamabad | 1993 | Early maturing, semi-erect, high yielding, tolerant to MYMV. |
| | Mash-3 | NARC, Islamabad | 1993 | Extra early, erect, high yielding,tolerant. to MYMV, suitable for rainfed areas. |
| | Mash-97 | AARI, Faisalabad | 1997 | Early maturity, semi-erect, high yielding tolerant to MYMV. |
| | Chakwal Mash-97 | BARI, Chakwal | 1997 | Early maturity, semi erect, high yielding, tolerant to MYMV |