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# IGKM 05-18-2: identified as high yielding and multiple disease resistance rabi mungbean genotype for Chhattisgarh state

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## ABSTRACT

*To enhance the yield potential in the rabi season, a high yielding and multiple disease resistant mungbean genotype, IGKM 05-18-2 has been developed through pedigree method from cross between Pairy Mung x Pusa Vishal at IGKV, Raipur, Chhattisgarh. The entry was tested in multilocation trial (12 locations) for three years (2017-18 to 2019-20) followed by testing in All India Coordinated Research Project on MULLaRP for a period of two years (2019-20 and 2020-21). It was also screened for various pests and diseases under pathological trials of AICRIP. Based on three years data (2017-18 to 2019-20) in state multilocation trials, during Rabi season, the entry IGKM 05-18-2 (902.40 Kg ha$^{-1}$) had shown 8.29 % yield increase over the best check i.e. Pairy Mung (833.27 Kg ha$^{-1}$). Likewise, under All India Coordinated Research Project (AICRP on MULLaRP) this entry shown ~~the~~ 6.46 % yield advantage over the best check VBN 4 based on the mean performance in IVT and AVT-1 trials. In addition to the yield advantages, it shown multiple resistances to MYMV, Cercospora leaf spot, Powdery mildew and root rot in co-ordinated trials whereas, it was found resistant against PM, MYMV and Alternaria leaf spot at station trial. The entry IGKM 05-18-2 showed moderate insect pest infestation and was considered as promising entry. The entry IGKM 05-18-2 was found with moderate insect pest (thrips, whiteflies and maruca pod borer) infestation and considered as promising entry and the higher seed yield was recorded than Local check LGG 450. The data of the tested entry revealed the mungbean genotype, IGKM 05-18-2 ~~is~~ found to have high yield potential, multiple disease resistant and most suitable for cultivation in rabi season of the state. This improved line with enhanced resistance for multiple diseases can also be further used as a resistant donor for transfer disease resistance genes in other elite cultivars.*

**Keywords**: Mungbean, Seed yield, Powdery mildew, MYMV, Maruca pod borer

## INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is one of the important short duration legume crop, cultivated since prehistoric times in India. It is a vital crop grown throughout Asia, Australia, South and North America, tropical and subtropical Africa (Parihar *et al.*, 2017). India is the largest mungbean-producing country, accounting for about 65% of the world acreage and 54% of the production (Baraki *et al.,* 2020). The productivity of mungbean in India is 601 Kg ha$^{-1}$ (IIPR, 2021) and its production has not considerably increased yet. The major constraints in achieving high yield of this crop are lack of genetic variability, poor harvesting index and susceptibility to diseases and pests. The mungbean suffers from several diseases, especially Cercospora leaf spot (*C.canescens, C. cruenta*), powdery mildew (*Erysiphe polygoni*), root disease complex (*Pythium spp., Rhizoctonia solani, Fusarium spp*.) and Mungbean Yellow Mosaic Virus (*Bemisia tabaci*). Despite the efforts, development of sustainable resistant cultivar with higher yields has not yet been successful due to narrow genetic bases of the present cultivars. Crop breeding programs are mostly confined to some major agro-ecology, particularly at the research stations, but the promising breeding lines are grown across the locations to assess their overall performance. A realistic and timely approach, to accelerate a varietal release programs, would require identifying strategic locations using different tactics. The multi-location trial is the prerequisite for cultivar testing followed by the testing of potential breeding lines by the All India Coordinated Research Project (AICRP) under the umbrella of the Indian Council of Agricultural Research (ICAR) to be released for cultivation. Therefore, the objectives of the present study were to evaluate the mungbean genotype in different agro-climatic regions and to screen for various pests and diseases under entomological and pathological trials.

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## MATERIALS AND METHODS

A cross involving Pairy Mung (high yielding with resistance to powdery mildew and suitable for Rabi season in Chhattisgarh) was used as a female parent and Pusa Vishal (a high yielding with bold and shiny grains and resistant to the mungbean yellow mosaic virus) was used as a male and cross was attempted in the year 2011 and after confirming the hybridity, $F_2$ was raised and elite plants were selected and the subsequent generations ($F_3$ to $F_6$) from 2013 to 2016 were handled through pedigree method of breeding (Figure1). A promising line IGKM 05-18-2 was selected in $F_6$ generation and was promoted to yield trials in 2017 and was evaluated in station trials and state level multilocation testing were carried out in three years *viz.*, 2017-18 to 2019-20. It was nominated for AICRP coordinated yield trials testing in 2019-20 and was tested under IVT and during 2020-21 for AVT 1. The entry was screened for various pests and diseases under entomological and pathological trials of AICRIP from 2019-20 and 2020-21.

## RESULTS AND DISCUSSION

In the current study, a cross was generated between Pairy Mung x Pusa Vishal to generate $F_1$ and superior plants were selected in segregating generations and uniform elite mungbean line IGKM 05-18-2 was identified for testing under different yield evaluation trials.

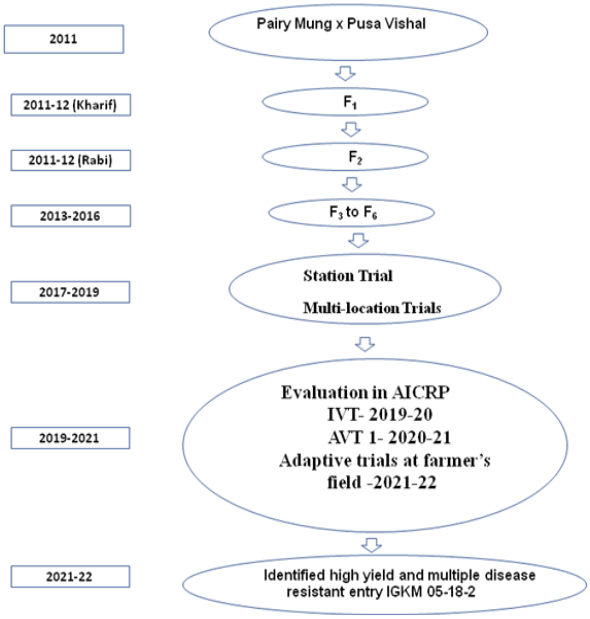


Fig. 1: Flow chart showing the steps of the development of IGKM 05-18-2

### Agro-morphological characterization of IGKM 05-18-2 based on DUS descriptor (PPV&FRA, 2001)

The distinguishing morphological characters of developed genotype IGKM 05-18-2 are given in Table 1. It is a high yielding, medium plant height, straight mature pod curvature, shiny seed lusture, medium seed weight (3.5 g) with resistance to MYMV, Cercospora leaf spot, Powdery Mildew and Root rot.

Table 1: DUS Characters of IGKM 05-18-2

| Characteristics | Description |
|---|---|
| Hypocotyl: Anthocyanin | Present |
| Time of flowering | Late |
| Plant: Growth habit | Erect |
| Plant: Habit | Determinate |
| Stem : Colour | Green |
| Stem: Pubescence | Present |
| Leaflet : Lobes (terminal) | Absent |
| Leaf: Shape | Ovate |
| Leaf: Colour | Dark green |
| Leaf : Vein colour | Green |
| Petiole : Colour | Green |
| Leaf : Size | Small |
| Flower: Colour of petal | Light Yellow |
| Pod : colour of premature pod | Green with pigmented suture |
| Pod : Pubescence | Present |
| Pod : Position | Above canopy |
| Plant : Height | Medium |
| Pod : Colour | Brown |
| Pod : Curvature of mature pod | Straight |
| Pod : Length | Short |
| Seed : Colour | Green |
| Seed : Shape | Drum |
| Seed : Lusture | Shiny |
| 100 Seed weight | Medium |

According to Protection of Plant Varieties and Farmers Right Act (PPV&FRA), 2001 characterization of a variety is prerequisite for providing protection to plant varieties based on distinctiveness, uniformity and stability (DUS) test apart from novelty. Therefore the characterization of IGKM 05-18-2 was done according to the Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on mungbean given by PPV & FR Authority, GOI, New Delhi (2007).

**Evaluation Trials**

The productivity of mungbean in India is quite low and unstable as compared to other countries. Consequently, the selection of high-yielding, stable genotypes and their proper use in a breeding program is the most practical approach to increase mungbean productivity. Testing of genotypes in multi-environment trial is essential to predict the presence of genotype x environment interaction. Evaluation of genotypes in diverse environments facilitate in identifying high-yielding and most stable genotypes (Luquez *et al.*, 2002; Fan *et al.*, 2007). Also, multiyear and multi-location testing is prerequisite before release of new genotypes for cultivation (Kumar *et al.*, 2020).

Table 2: Performance of IGKM 05-18-2 at Raipur Station trials during Rabi (2017-18)

| Yield and phenological traits | IGKM 05-18-2 | Pairy Mung (Best Check) | % increase over best check |
|---|---|---|---|
| Yield (Kg ha$^{-1}$) | 1569.03 | 1379.03 | 13.78 |
| Days to maturity | 104 | 105 | |
| 100 seed weight (g) | 3.5 | 3.3 | |

**Performance of IGKM 05-18-2 in state and coordinated yield evaluation trials**

The advanced breeding lines undergo a multi-location trial and national level trials before being released as a superior cultivar (Parihar *et al.*, 2022). The location-specific performance of a crop is mostly dependent on environmental (temperature, rainfall, humidity, sunshine hours) and edaphic conditions as genotypes differed substantially across the different site. To understand the response of mungbean genotype in various environments station trial and multilocation trials were conducted. This approach will be helpful in identifying and selecting the stable, high yielding genotypes that are best suited for a given set of environmental conditions (Islam *et al.*, 2021). In this regard, the station varietal trial (SVT) conducted during *Rabi* 2017-18 the entry IGKM 05-18-2 recorded the yield of 1569.03 Kg ha$^{-1}$ against the best check Pairy Mung (1379.03 Kg ha$^{-1}$) with an advantage of 13.78 % (Table 2). Multiyear data analysis would provide better estimates of genotype performance. The mungbean entry IGKM 05-18-2 was tested at 12 locations *viz*., Raipur, Bhatapara, Kawardha, Bilaspur, Jagdalpur for three consecutive years during 2017-18 to 2019-20 in rabi season. In the pooled data of multilocation testing of entries, the entry IGKM 05-18-2 registered the mean yield of 902.40 Kg ha$^{-1}$against the checks Pairy Mung (833.27 Kg ha$^{-1}$) and HUM 16 (697.22 Kg ha$^{-1}$) with an yield advantage of 8.29 % and 29.42%, respectively (Table 3).

Table 3: Performance of IGKM 05-18-2 in state multilocation trial during Rabi 2017-18 to 2019-20

| Entry | 2017-18 (Kg ha$^{-1}$) | 2018-19 (Kg ha$^{-1}$) | 2019-20 (Kg ha$^{-1}$) | Mean (Kg ha$^{-1}$) | % increase over |
|---|---|---|---|---|---|
| | 5 loc.[a] | 3 loc.[b] | 4 loc.[c] | | |
| IGKM 05-18-02 | 878.08 | 884.13 | 945.00 | 902.40 | |
| HUM 16 (Ch) | 610.74 | 712.92 | 768.00 | 697.22 | 29.42% |
| Pairy Mung (C) | 768.06 | 890.94 | 840.83 | 833.27 | 8.29% |
| No. of locations | 5 | 3 | 4 | | |
| CD at 5% | 192.57 | 258.67 | 102.47 | | |
| CV (%) | 12.70 | 12.53 | 11.54 | | |

*a=Raipur, Bhatapara, Kawardha, Bilaspur, Jagdalpur; b=Raipur, Bhatapara, Kawardha; c=Raipur, Bhatapara, Kawardha, Jagdalpur*

The entry IGKM 05-18-2 was tested at 08 locations for two consecutive years in AICRP trials Initial Variety Trial (IVT) in South Zone during *Rabi* 2019-20 and was promoted to Advanced Varietal Trial 1 (AVT-1) in 2020-21. It was revealed that IGKM 05-18-2 exhibited high yield potential (989.88 Kg ha$^{-1}$) and recorded 6.46%, 17.87%, 22.31% and 30.13% higher yield than the checks VBN-4, VBN (Gg)2, Pusa 9072 and Co 6, respectively (Table 4).

Table 4: Performance of IGKM 05-18-2 in Co-ordinated trial IVT and AVT 1 in South Zone

| Entry | Seed Yield (Kg ha$^{-1}$) | | Mean | % increase over |
|---|---|---|---|---|
| | 2019-20 | 2020-21 | | |
| IGKM 05-18-2 | 942.75 | 1037.0 | 989.88 | |
| VBN-4 (C) | 867.75 | 991.8 | 929.78 | 6.46 |
| VBN (Gg)2(C) | 829.25 | 850.3 | 839.78 | 17.87 |
| Pusa 9072 (C) | 725.25 | 893.3 | 809.28 | 22.31 |
| CO 6(C) | 823.5 | 697.8 | 760.65 | 30.13 |
| No. of Locations | 4 | 4 | | |
| Name of trial | IVT | AVT 1 | | |
| CD at 5% | 216.14 | 137.78 | | |
| CV (%) | 15.37 | 10.21 | | |

*Source: Page No. 70, Annual Report Mungbean and Urdbean 2019-20, Source: Page No. 85, Annual Report Mungbean and Urdbean 2020-21*

**Evaluation of IGKM 05-18-2 in Pathological and Entomological trials**

The productivity of mungbean in India is low due to abiotic and biotic constraints (Pratap *et al.*, 2019). The major biotic factors include diseases such as yellow mosaic, anthracnose, powdery mildew, Cercospora leaf spot (CLS), dry root rot, halo blight and tan spot and insect-pests especially bruchids, whitefly, thrips, aphids and pod borers (War *et al.*, 2017; Pandey *et al.*, 2018). In order to improve productivity and stabilize the production, there is a need to develop varieties resistant to biotic and abiotic stress factors and for which availability of stable sources of resistance is a pre-requisite. Though chemical control measures are available for biotic stresses, but they are not always economically and physically feasible. In this context, the Mungbean genotype IGKM 05-18-2 was evaluated for major diseases and insects in state and coordinated trials.

Table 5: Reaction of IGKM 05-18-02 against MYMV, powdery mildew (PM) and Alternaria leaf spot during Rabi 2021-22 at Station Trial, Raipur

| Entry | PM (0-5) | MYMV (1-9) | Alternaria leaf spot (1-9) |
|---|---|---|---|
| IGKM 05-18-2 | 1 | 2 | 3 |
| Pairy Mung (Resistant) | 2 | 4 | 3 |
| HUM 12 (Susceptible) | 5 | 4 | 3 |
| HUM 16 (Susceptible) | 5 | 4 | 3 |

The entry IGKM 05-18-2 was tested in Pathological trials during Rabi 2020-21 at Raipur station and found resistant against PM, MYMV and Alternaria leaf spot (Table 5).

Table 6: Reaction of IGKM 05-18-2 to major diseases at multilocations over the years

| Entry | MYMV (1-9 Scale) | | | Disease reaction | Cercospora Leaf Spot (1-9 Scale) | | | Disease reaction | Powdery Mildew (0-5 Scale) | | | Disease reaction | Root Rot (1-9 Scale) | | | Disease reaction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019-20 | 2020-21 | Mean | | 2019-20 | 2020-21 | Mean | | 2019-20 | 2020-21 | Mean | | 2019-20 | 2020-21 | Mean | |
| IGKM 05-18-2 | 2.25 | 2.6 | 2.4 | HR | 2.5 | 3.5 | 3 | R | 2.2 | 1.6 | 1.9 | MR | 2 | 3 | 2.5 | R |
| VBN 4 | 2.5 | 3.0 | 2.8 | R | 3 | 3 | 3 | R | 2.6 | 2.33 | 2.5 | MS | 3 | 5 | 4 | MR |
| VBN(Gg) 2 | 4.25 | 5.33 | 4.8 | MS | 2 | 4 | 3 | R | 2.8 | 2.0 | 2.4 | MR | 2 | 5 | 3.5 | MR |
| Pusa 9072 | 3.75 | 3.33 | 3.5 | MR | 2.5 | 4.5 | 3.5 | MR | 3.4 | 2.66 | 3.0 | MS | 3 | 4 | 3.5 | MR |
| No. of locations | 4 | 3 | | | 2 | 2 | | | 5 | 3 | | | 1 | 1 | | |
| Name of trial | IVT | AVT 1 | | | IVT | AVT 1 | | | IVT | AVT 1 | | | IVT | AVT 1 | | |

*Source: Page No. 225 and 226, Annual Report Mungbean and Urdbean 2019-20, Source: Page No. 253, Annual Report Mungbean and Urdbean 2020-21*

It was tested in Pathological trials for two years (2019-20 and 2020-21). Based on the screening results, it was inferred that IGKM 05-18-2 was resistant at all locations to MYMV whereas, it has shown resistant reaction to cercospora leaf spot , powdery mildew and root rot during *Rabi 2019-20,* whereas, it showed multiple resistances to MYMV, Cercospora leaf spot, Powdery mildew and root rot during *rabi 2020-21*. However, the entry IGKM 05-18-2 was resistant to powdery mildew at all locations (Table 6).

The entry IGKM 05-18-2 showed moderate insect pest infestation and was considered as promising entry. The higher seed yield was recorded as compared to all the checks during Rabi 2019-20, whereas, during Rabi 2020-21, the entry IGKM 05-18-2 was found with moderate insect pest (thrips, whiteflies and maruca pod borer) infestation and considered as promising entry and higher seed yield was recorded than Local check LGG 450 (Table No.7).

Table 7: Reaction of IGKM 05-18-2 to major pests at Lam over the years

| Entry | 2019-20 | | | | | | | 2020-21 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Thrips (no./3 leaves) | | Whiteflies (no./3 leaves) | | Maruca Pod borer | | Yield (Kg ha$^{-1}$) | Thrips (no./3 leaves) | | Whiteflies (no./3 leaves) | | Maruca Pod borer | | Yield (Kg ha$^{-1}$) |
| | 30 DAS | 45 DAS | 30 DAS | 45 DAS | Larva/ plant | % Pod damage | | 30 DAS | 45 DAS | 30 DAS | 45 DAS | Larva/ plant | % Pod damage | |
| IGKM 05-18-2 | 6.0 | 2.7 | 3.9 | 2.0 | 0.5 | 7.90 | 6.38 | 3.0 | 5.1 | 2.3 | 4.0 | 1.4 | 21.31 | 2083 |
| VBN 4 | 5.7 | 2.6 | 3.7 | 1.5 | 1.1 | 9.95 | 5.13 | - | - | - | - | - | - | - |
| VBN(Gg)2 | 6.1 | 2.1 | 4.2 | 1.4 | 0.6 | 6.53 | 2.83 | - | - | - | - | - | - | - |
| Pusa9072 | 6.3 | 2.6 | 3.8 | 1.2 | 0.6 | 6.27 | 1.21 | - | - | - | - | - | - | - |
| LGG 450 | - | - | - | - | - | - | - | 4.0 | 5.8 | 3.6 | 5.5 | 2.0 | 23.34 | 1833 |
| No. of locations | 1 | | 1 | | 1 | | | 1 | | 1 | | 1 | | |
| Name of trial | IVT | | IVT | | IVT | | | AVT 1 | | AVT 1 | | AVT 1 | | |

*Source: Page No. 299, Annual Report Mungbean and Urdbean 2020-21, Source: Page No. 271, Annual Report Mungbean and Urdbean 2019-20*

Conventionally, the morphological markers are used generally to establish the identity of genotypes across the crops. But these descriptors are not authentic as they have some limitations. To overcome these limitations molecular markers are now being used due to the discrimination power and their reliability of the test.

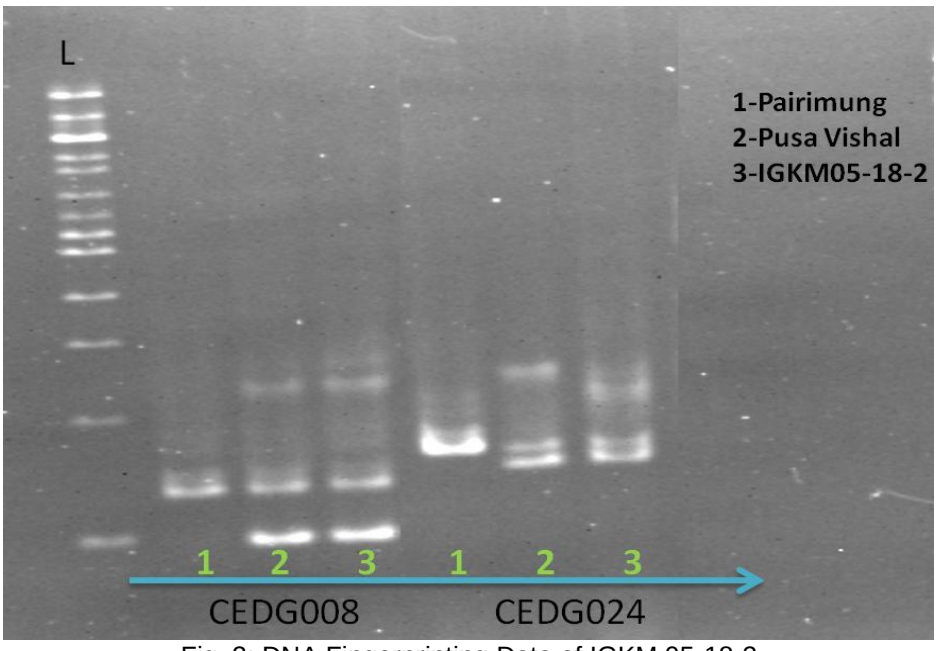


Fig. 2: DNA Fingerprinting Data of IGKM 05-18-2

The molecular profiles of IGKM 05-18-2 along with both the parents Pairy Mung and Pusa Vishal were performed at Richharia Research laboratory of IGKV, Raipur. Two SSR markers namely, CEDG008 and CEDG024 were found polymorphic and distinguished the test genotype with the Pairy Mung (Figure 2). Molecular markers have been extensively applied for revealing the level of genetic diversity in various crops. Zhao *et al.* (2019) and Mwangi *et al.*, (2021) used SSR markers to differentiate mung bean varieties at the DNA level.

## CONCLUSION

Considering the superior performance of the Mungbean genotype, IGKM 05-18-2 is found to have high yield potential, multiple disease resistant and most suitable for cultivation in rabi season of the state. This improved line with enhanced resistance for multiple diseases can also be further used as a resistant donor for transfer disease resistance genes in other elite cultivars.

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