Characterization of the green gram (Vigna radiata L.) genotypes through both morphological and biochemical parameters

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ABSTRACT

Eight genotypes of greengram were collected in the present investigation from AICRP on MULLaRP, Bidhan Chandra Krishi Viswavidyalaya (BCKV) and they were characterized with ten quantitative, nineteen qualitative and two biochemical parameters as per the NBPGR descriptor. Grouping based on DUS descriptors indicate the existence of genetic diversity within the genotypes. These eight genotypes were evaluated and characterized for 31 DUS descriptors. However, 21 characters out of 31 characters of DUS descriptors differed significantly indicating a large and exploitable amount of genetic variability for the individual elite improved line profile development for identification and protection. The elite lines are similar for the important plant traits like semi erect and determinate growth habit but the development of erect types is the need of hour and indicates the incorporation of new germplasm for the improvement of this trait in the present material. Genotypes could be easily identified through some unique characters: SML-1822 could be identified amongst genotypes studied here through its semi-erect growth habit, green stem colour with purple shade, dark green leaf colour, light yellow flower colour and bearing pods below canopy; identification of IPM-512-1 and TMB-37 could be made through seeds with drum shape and dull seed luster respectively; and Pusa Vishal through its leaves with dark green colour along with intermediate pod position and larger seed size. Samrat is having highest amount of protein as well as carbohydrate content among these genotypes. Thus, the DUS descriptor data generated with unique profiles of the elite improved lines can be used for the registration with PPV & FRA and seed purity testing.

Introduction

Vigna radiata L. wilczek which is commonly known as mungbean or greengram is one of the most widely distributed crop species among the six Asiatic Vigna species. Essential amino acids especially lysine and tryptophan are mainly found in green gram along with other proteins. It is also having certain other added features compared to other pulses like the crop is relatively drought tolerant and well adapted to a varied soil conditions including light soils and it can thrive well even under limited irrigation. Moreover, it is very well suited to crop rotation and crop mixtures (Uzoh et al., 2019). However, green gram yield advantage is major drawback for this crop that is well below the optimum level. The average yield of mungbean is very low not only in India (425 kg/ha) as well as in entire tropical and subtropical Asia. Other than management factors, the major cause for the low productivity can be described to the inherently low yield potential of the cultivars coupled with susceptibility to diseases. Due to the limited variability prevailed among the parents used for
hybridization; the success had been very limited in most of the studies (Bordolui et al., 2015). There is always a possibility of improving the crop by incorporating diversified gene present in the germplasm. Sometime stepwise utilization of primary gene pools of this crop can result in tremendous improvement in yield. It is essential to evaluate the available germplasm collections in order to utilize the variability available in the primary gene pool, Hence, this study was taken up to evaluate and characterize available germplasm of green gram using NBPGR descriptors with a view to evaluate the available germplasm using the descriptors and to form the core collection.

Material and Methods
Characterization of greengram genotypes was traditionally carried out by using morpho-agronomic traits. PPV & FRA (Protection of Plant Varieties and Farmers’ Rights Authority) has come up with a set of DUS (Distinctiveness, Uniformity and Stability) descriptors for characterization of the lines for their registration and protection. Thus, in the present study, eight genotypes were characterized using PPV&FRA descriptors to know the extent variability present in these genotypes. The genotypes were collected from AICRP on MULLaRP, BCKV. The laboratory experiment was done in seed testing laboratory and field performance was observed in ‘D’-Block Farm, Kalyani, BCKV, West Bengal during 2019 and 2020. Seeds were sown in individual plots following standard agronomic practices and intercultural operations in the plot, with three replications following Randomized Block Design. Spacing was 30 cm between the rows, 10 cm between the plants and 50 cm between the two plots. Each plot was 2m length and 2m breadth. The different morphological and biochemical parameters such as hypocotyl: anthocyanin colouration, growth habit, time of flowering, plant habit, stem colour, stem pubescence, leaf colour, leaf pubescence, leaf shape, flower colour, premature pod colour, pod pubescence, pod position, pod colour at maturity, curvature of pod, seed colour, seed luster, seed shape, seed size, protein content and carbohydrate content were recorded. The different quantitative characters like field emergence (%), plant height at 15 DAS (cm), plant height at first flowering (cm), days to first flowering, number of nodule plant$^{-1}$, days to 50 % flowering, days to maturity, number of pods plant$^{-1}$, number of seeds pod$^{-1}$, and seed yield plant$^{-1}$ (g) were also recorded.

Results and Discussion
The results are discussions are detailed out below:

Characterization through qualitative parameters
Morphological characteristics provide the basic information about the genetic variability among different genotypes. For morphological characterization of such eight genotypes, 19 qualitative characters were recorded. The trait, anthocyanin colouration, was recorded at seedling stage and was noticed in all genotypes. This is the trait which is highly used in breeding programmes for differentiation of genotypes, and also useful in maintenance breeding and Intellectual property protection. Similar exploitation of morphological traits in mungbean was reported by Mukherjee and Pradhan (2002); Khattak et al. (2000); Bordolui et al. (2006) and Patel et al. (2019). The characters, time of flowering, plant habit and stem pubescence, were recorded at 50% flowering stage and variation among the genotypes was not observed. All the genotypes showed early flowering, determinate plant habit and presence of stem pubescence indicating these morphological characters are not useful in characterization of these genotypes. Erect type growth habit was noticed in Pusa Vishal, PM-11-9, IPM-2-3, Meha, Samrat, IPM-512-1, TMB-37, while SML-1822 exhibited semi-erect type. All the genotypes were of determinant plant habit. Stem colour was recorded at 50% flowering stage and it varied among the genotypes: for Meha and SML-1822, stem colour was green with purple tinge, while other genotypes were observed with green stem colour. No variation was observed for leaf shape: all genotypes were of ovate leaf shape. Dark green leaves were observed for Pusa Vishal and SML-1822, while remaining genotypes recorded leaves of green colour. SML-1822 could be identified as the only genotype bearing light yellow flowers, while yellow colour flowers were noticed for all other genotypes. Jain et al. (2002) reported the usefulness of flower characteristics in characterization of greengram. Premature pod colour was recorded when pods were fully
| SN | Characters                                      | Pusa Vishal | PM-11-9 | IPM-2-3 | Meha | Samrat | IPM-512-1 | TMB-37 | SML-1822 |
|----|------------------------------------------------|-------------|---------|---------|------|--------|-----------|--------|----------|
| 1. | Hypocotyl: Anthocyanin colouration             | Present     | Present | Present | Present | Present | Present | Present | Present  |
| 2. | Growth habit                                   | Erect       | Erect   | Erect   | Erect | Erect  | Erect     | Erect  | Semi-erect |
| 3. | Time of flowering                              | Early       | Early   | Early   | Early | Early  | Early     | Early  | Early    |
| 4. | Plant habit                                    | Determinate | Determinate | Determinate | Determinate | Determinate | Determinate | Determinate | Determinate |
| 5. | Stem colour                                    | Green       | Green   | Green   | Green with purple | Green | Green | Green | Green with purple |
| 6. | Stem pubescence                                | Present     | Present | Present | Present | Present | Present | Present | Present  |
| 7. | Leaf colour                                    | Dark green  | Green   | Green   | Green | Green  | Green | Green | Dark green |
| 8. | Leaf pubescence                                | Present     | Present | Present | Present | Present | Present | Present | Present  |
| 9. | Leaf shape                                     | Ovate       | Ovate   | Ovate   | Ovate | Ovate  | Ovate     | Ovate  | Ovate    |
| 10. | Flower colour                                  | Yellow      | Yellow  | Yellow  | Yellow | Yellow | Yellow   | Yellow | Light Yellow |
| 11. | Premature Pod colour                           | Green       | Green   | Green   | Green | Green  | Green | Green | Green |
| 12. | Pod pubescence                                 | Present     | Present | Present | Present | Present | Present | Present | Present  |
| 13. | Pod position                                   | Intermediate | Above canopy | Intermediate | Above canopy | Above canopy | Above canopy | Above canopy | Not visible |
| 14. | Pod colour at maturity                         | Black       | Black   | Black   | Black | Black  | Black | Black | Black |
| 15. | Curvature of pod                                | Straight    | Straight | Straight | Straight | Straight | Straight | Straight | Straight |
| 16. | Seed colour                                    | Green       | Green   | Green   | Green | Green  | Green | Green | Green |
| 17. | Seed luster                                    | Shiny       | Shiny   | Shiny   | Shiny | Shiny  | Shiny | Dull  | Shiny |
| 18. | Seed shape                                     | Oval        | Oval    | Oval    | Oval | Oval   | Oval | Oval | Oval |
| 19. | Seed size                                      | Large       | Medium  | Medium  | Medium | Large  | Medium | Large | Medium |
developed and all genotypes recorded to bear pods having green colour. Pod pubescence was noticed irrespective of the genotypes. All the genotypes exhibited straight pods but no curvature was noticed at all. During maturity each genotype was observed with black pods. Similar report of straight pods without curvature was reported by Sunil et al. (2014) in their study in greengram. Pod position was intermediate in Pusa Vishal and IPM-2-3, but it was below canopy in SML-1822 only, while other genotypes exhibited above canopy pod position. All the genotypes produced seeds of green seed colour. Seed luster of TMB-37 were dull and the other genotypes exhibited shiny seed luster. For seed shape of the genotypes, Pusa Vishal, PM-11-9, IPM-2-3, Meha, Samrat, TMB-37 and SML-1822 were of oval, while IPM-512-1 only exhibited seeds of drum shape. Seed size (100 seed weight) was
### Table 3: Characterization of green gram genotypes through quantitative characters (pooled).

| Genotype   | Field emergence (%) | Plant height at 15 DAS (cm) | Plant height at first flowering (cm) | Days to first flowering | Days to 50% flowering | Days to maturity | Number of nodules plant⁻¹ | Seed Yield plant⁻¹ (g) |
|------------|---------------------|-----------------------------|--------------------------------------|-------------------------|-----------------------|------------------|-----------------------------|------------------------|
| Pusa Vishal| 75.81 (60.52)       | 12.54                       | 43.23                                | 35.33                   | 9.31                  | 42.67            | 73.00                       | 27.93                  | 10.45                  | 14.86                  |
| PM-11-9    | 77.73 (61.82)       | 9.13                        | 34.64                                | 36.33                   | 9.40                  | 44.00            | 73.67                       | 24.57                  | 10.67                  | 13.33                  |
| IPM-2-3    | 76.09 (60.71)       | 10.02                       | 35.57                                | 37.67                   | 8.22                  | 44.67            | 71.00                       | 24.88                  | 10.47                  | 13.27                  |
| Meha       | 79.65 (63.16)       | 10.44                       | 36.39                                | 36.00                   | 9.69                  | 43.00            | 74.00                       | 22.89                  | 9.42                   | 10.97                  |
| Samrat     | 78.23 (62.17)       | 9.26                        | 32.00                                | 38.67                   | 8.64                  | 45.67            | 71.67                       | 28.53                  | 11.19                  | 16.25                  |
| IPM-512-1  | 79.30 (62.91)       | 10.19                       | 45.51                                | 38.67                   | 9.93                  | 46.00            | 71.33                       | 26.46                  | 12.42                  | 16.72                  |
| TMB-37     | 77.66 (61.77)       | 9.87                        | 37.44                                | 33.67                   | 9.79                  | 42.00            | 72.33                       | 28.32                  | 12.21                  | 17.62                  |
| SML-1822   | 78.26 (62.18)       | 9.74                        | 36.63                                | 37.00                   | 10.30                 | 44.67            | 74.00                       | 27.82                  | 10.54                  | 14.92                  |
| SEm(±)     | 0.135               | 0.184                       | 0.26                                 | 0.398                   | -                     | 0.496            | 0.57                        | 0.559                  | 0.153                  | 0.386                  |
| LSD (0.05%)| 0.413               | 0.565                       | 0.797                                | 1.22                    | -                     | 1.519            | 1.747                       | 1.713                  | 0.468                  | 1.183                  |

(Figures in parenthesis are arc-sin transformed values.)

### Table 4: Characterization of green gram genotypes through biochemical characters.

| Genotype   | Protein content (mg g⁻¹) | Carbohydrate content (mg g⁻¹) |
|------------|--------------------------|------------------------------|
| Pusa Vishal| 225.254                  | 637.198                      |
| PM-11-9    | 221.232                  | 635.856                      |
| IPM-2-3    | 225.219                  | 636.221                      |
| Meha       | 222.751                  | 636.087                      |
| Samrat     | 225.284                  | 637.416                      |
| IPM-512-1  | 225.263                  | 637.312                      |
| TMB-37     | 225.245                  | 636.871                      |
| SML-1822   | 221.080                  | 635.721                      |
| SEm(±)     | 0.045                    | 0.087                        |
| LSD (0.05%)| 0.137                    | 0.264                        |
medium for PM-11-9, IPM-2-3, Meha, IPM-512-1, SML-1822, while large seeds were produced by Pusa Vishal, Samrat and TMB-37. Similar reports of exploiting the seed characters' variability in greengram was reported by Venkateswarlu (2001), and Khajudparn and Tantasawat (2011). Thus, it is clear from both the tables 1 & 2 that genotype(s) could be easily identified through some unique characters: SML-1822 could be identified amongst the eight genotypes studied here in through its semi-erect growth habit, green stem colour with purple shade, dark green leaf colour, light yellow flower colour and bearing pods below canopy; IPM-512-1 and TMB-37 could be identified through seeds with drum shape and dull seed luster respectively among the genotypes; and Pusa Vishal through dark green leaves with intermediate pod position and larger seed size. Therefore, the present study indicates the importance of morphological characterization using DUS descriptors for the registration, maintenance and protection of genotypes.

Characterization through quantitative parameters

Significant variation was noticed for all the quantitative characters among the genotypes excepting number of nodules plant$^{-1}$. Highest field emergence was observed for Meha (79.65%) followed by IPM-512-1; while lowest field emergence (75.81%) was recognized for Pusa Vishal. Maximum number of nodule plant$^{-1}$ (10.30) was found for SML-1822, though non-significant, followed by IPM-512-1 and minimum number of nodule plant$^{-1}$ for IPM-2-3 but this trait varied non-significantly among the genotypes. After 15 days of sowing, the highest plant height (12.54 cm) was observed in Pusa Vishal followed by IPM-512-1 and it was lowest in PM-11-9. But during first flowering stage, Pusa Vishal and IPM-512-1 interchanged their position i.e., highest was observed for IPM-512-1 followed by Pusa Vishal and at that stage, lowest was observed for Samrat. Minimum days required for 50% flowering (42.00) was observed for TMB-37 preceded by Pusa Vishal; non-significant variation was observed between these two genotypes; but the genotypes varied significantly for this character. Least days were taken for maturity by IPM-2-3 (71.00) preceded by IPM-512-1 and Samrat. These three genotypes performed statistically at par with each other. Highest number of pods plant$^{-1}$ was recorded for Samrat (28.53) followed by TMB-37, while it was lowest for PM-11-9. Seed yield plant$^{-1}$ (g) was maximum for TMB-37 followed by IPM-512-1 and minimum was found in IPM-2-3. These results are similar with the findings of Uddin et al. (2010); Dash and Rautaray (2017). Thus, clear variation for these quantitative characters considered here for identification of the genotypes, therefore, could be utilized in a better way for identification of the genotypes, especially for the genotypes occupying lowest and/or highest position for individual character.

Characterization through biochemical parameters

Two biochemical parameters i.e., protein and carbohydrate contents were observed for quantitative characterization of the genotypes. Highest protein was recorded in Samrat followed by IPM-512-1, Pusa Vishal and TMB-37; though these genotypes were statistically at par. Lowest protein was observed in SML-1822. But among the genotypes protein content varied significantly. Highest carbohydrate content also was observed in Samrat followed by IPM-512-1, Pusa Vishal and TMB-37; non-significant variation was observed between Samrat and IPM-512-1 and lowest was observed for SML-1822. But among the genotypes, this trait varied significantly. Similar type of result was observed by Blessing and Gregory (2010). As a main storage protein mung beans contain higher amounts of protein with globulin and albumin in the seeds (Kirchhoff, 2002). However, the lack of raffinose may be the reason of having smaller amount carbohydrate, resulting in hydrolysis of sucrose to supply energy (Mubarak, 2005).

Conclusion

Genotypes studied in this experiment could be easily identified through some unique characters: SML-1822 could be identified amongst the eight genotypes studied here in through its semi-erect growth habit, green stem colour with purple shade, dark green leaf colour, light yellow flower colour and bearing pods below canopy; identification of IPM-512-1 and TMB-37 could be made through seeds with drum shape and dull seed luster respectively; and Pusa Vishal through its leaves with dark green colour along with intermediate pod position and larger seed size. However, Samrat is having highest amount of protein as well as carbohydrate contents among these genotypes.
Conflict of interest
The authors declare that they have no conflict of interest.

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