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Studies on physiological traits of mungbean (*Vigna radiata* L.) genotypes

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Abstract
Fifteen greengram (*Vigna radiata* L.) genotypes were evaluated for physiological traits in a field experiment conducted during *kharif* season 2021- 2022 at Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Observations were recorded on 20^{th}, 40^{th}, 60^{th} DAS and at harvesting stage. Results revealed that the highest mean leaf area per plant were 143.04, 558.72, 610.67 and 462.03 in genotype BM-21-1 on 20 DAS, 40 DAS, 60 DAS and at harvest stage respectively. Highest mean leaf area duration was 31.40 recorded in greengram genotype Phule M-504-20-27 at 41-60 DAS compared to rest genotypes of greengram. Mean leaf area index (LAI) was highest in Phule AKM-1606 (0.23) on 20^{th} DAS, 1.48, 1.73 and 1.44 were recorded in 40^{th}, 60^{th} DAS and at harvest respectively. Highest mean chlorophyll content (SPAD Reading) was 71.10 recorded in genotype BM-21-1 among other at harvest stage. Mean shoot biomass (g) varied from 0.09-18.23 grams in different genotypes of greengram. Significantly highest mean shoot biomass was observed in genotype BM-21-1compared to rest genotypes of greengram. Mean root biomass highest showed by genotype BM-21-1, 2.37 at harvest stage. These results not only provide valuable insights into the natural variations present in mungbean populations but also emphasize the importance of choosing and breeding genotypes with specific physiological traits to improve the overall performance and yield of crops.

Keywords: *Vigna radiata* L., leaf area per plant, leaf area, leaf area index, chlorophyll content and shoot and root biomass

Introduction
Pulses are a part of the daily diet of many vegetarians around the world. Pulses are rich in protein content. Pulse crops have a unique role to play in the global nitrogen cycle, as legumes and pulses fix atmospheric nitrogen in soils. Pulses are popularly known as Poor man's meat and rich man's vegetable. They contribute significantly to the nutritional security of the country. Among pulses, greengram (*Vigna radiata* L. Wilczek) is one of the most ancient and extensively grown pulse crops of India Rakavi *et al* 2019 [7]. India is a major pulse growing country in the world, which shares 33% and 28% of the global area and production respectively. Greengram (*Vigna radiata* L.), also known as mungbean, is an important grain legume containing a high amount of digestible protein, amino acids, sugar, minerals, soluble dietary fibres, and vitamins. It is cultivated across seasons, in different environments, and in variable soil conditions in the South and South-East Asia, Africa, South America, and Australia (Parihar *et al*., 2017) [5]. Greengram also helps in sustaining the fertility status of the soil by fixing large amount of atmospheric nitrogen through root nodules and thereby helps the succeeding crops. Mung bean fixes atmospheric nitrogen (58-109 kg/ha) in symbiosis with Rhizobium, by which the crop not only meet its own nitrogen demand but also improves the soil fertility (Ali and Gupta, 2012) [1].
Physiological characters like leaf area, light interception, chlorophyll content, chlorophyll stability index, total dry matter production as well as yield differ with genotypes (Dhivya *et al*., 2013) [2]. Therefore, it is necessary to identify the genotype(s) that can fit to the environmental conditions and minimize the effect of environment on production. Hence, the understanding of physiological traits of the genotypes growing seasons is an essential step towards identifying suitable genotypes. Keeping the above in view an investigation was carried out to study the performance of greengram genotypes in terms of physiological parameters in relation to kharif season.

Materials and Methods

The present investigation was carried out at Sorghum Research Station Farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, India during *Kharif* season, 2021. Seeds were obtained from Agriculture research station (ARS), Badnapur, Maharashtra. These 15 genotypes of green gram (*Vigna radiata* L) such as Phule chetak, PKVM-8802, BPMR-145(Ch), BM-2002-1(Ch), BM-2003-2(Ch), Phule M-504-20-27, Phule M-818-8, Phule M-402-2-1, BM-21-1, BM-21-2, BM-2019-10, AKM-12-28, AKM-1606, AKM-1609 and AKM-1801. A field trial was laid under a Randomized Block Design (RBD) with three replications; observation was recorded on five physiological characters (as detailed in material and methods) among the fifteen genotypes on 20 DAS, 40 DAS, 60 DAS and at harvesting stage. Therefore, selection of genotypes based on these traits could bring about desired improvement in yield of green gram cultivars.

Physiological Traits

Leaf area per plant (cm^2)

All leaves on the plants were graded into three grades *viz*. big, medium and small. The grade wise leaves were counted and maximum length and breadth of this representative leaf sample were measured and leaf area was calculated by using the following formula for each grade.

A= L×B×F×N

Where, A= leaf area (cm2) under particular group, L= Maximum length of representative leaf (cm2), B= Maximum breadth of representative leaf (cm2), N= Number of leaves in each grade,

F= Correction factor (0.7117).

Leaf area duration

LAD expresses in qualitative terms as to how long a crop maintain its active assimilatory tissue *i.e.*, leaves.

$LAD = ((L_1+L_2)/2\ (t_2-t_1) + ((L_2 + L_3)/2\ (t_3 - t_2) + \ldots\ldots\ldots\ldots$

Where,

L_1, L_2 = LAI at time t1, $t_2 - t_1$ = the interval between two consecutive stags in days.

Leaf area index

Since the crop yield is to be assessed per unit ground area instead of per plant, the leaf area existing on unit ground area was proposed by Watson. (1947). Leaf area index is the ratio of leaf area to ground area occupied by crop plant. Leaf area index per plant was calculated by using the following formula.

LAI= Leaf area/plant (cm2) /Ground area/plant (cm2)

Chlorophyll content

The chlorophyll content index of intact leaf was measured by using the instrument "SPAD 502". The observations were recorded during the day time between 11 am to 14 pm. For recording the observations three representative plants were selected from each genotype and replication. The third leaf was selected and recorded the observations. Mean values of chlorophyll content of these three leaves of three plants were calculated.

Root and shoot biomass (g)

The whole plant is oven dried at 80 ± 2^0 for 72 hours to constant weight and after that roots and shoot cut and separates from each other and weigh the weight of shoot and root separately of three oven dry samples of each genotype in their respected replication and their average is taken.

Results and Discussion

Leaf area per plant (cm^2)

The relevant periodical data pertaining to leaf area per plant (cm^2) are depicted graphically Fig 1. The difference in mean leaf area per plant due to different genotypes was statistically significant at all the growth stages. From the results, it was observed that, in all genotypes mean leaf area increased gradually up to 20-60 DAS and showed reduce towards maturity. The mean leaf area per plant increased in all the genotypes up to 60 DAS and there after it decreased considerably due to senescence of leaves. The genotype BM-21-1 (610.67 cm^2) maintained high leaf area followed by AKM-1606 (570.79 cm^2) and BPMR-145 (538.96 cm^2) at 60 DAS. High leaf area of BM-21-1 might be because of its more growth in respect to height, higher number of leaves, larger size of leaves and slow rate of leaf shedding. The leaf area was observed to be lowest at preflowering period but increased during flowering period in all genotypes. All genotypes maintained good canopy at flowering. Similar results were found by Vijaylaxmi and Bhattacharya (2012) [8].

Leaf area duration (LAD)

The data pertaining on leaf area duration recorded at different stages were graphically depicted in Fig 3. There was gradual increase of LAD upto 60 DAS and decreased there after till harvest. Leaf area duration denotes leafiness of crop till harvest. Significant differences were observed between genotypes through all the growth stages. Mean LAD during 41-60 days of crop stage was 25.63. During 41-60 days of crop growth stage genotype AKM-1606 (30.50) recorded maximum LAD followed by genotypes Phule M-504-20-27 (21.85) and BM-2003-2 (21.35). Lowest LAD recorded during this crop stage was in genotype AKM-1609 (20.58). At 61- at harvest days of crop stage the mean LAD was 10.62. In this period the genotype Phule chetak (15.48) maintained highest LAD followed by genotype BPMR-145 (Ch) (13.24) and BM-2019-10(13.00). The genotype AKM-1609 (6.44) recorded lowest LAD.

Leaf area index (LAI)

Data depicted graphically Fig 3. Leaf area index was recorded as various days after sowing of Mungbean genotypes. The difference in mean leaf area index due to different genotypes was statistically significant at all the growth stages. As we know leaf area index is directly proportional to leaf area hence from the results, it was observed that, in all genotypes mean leaf area index increased gradually up to 20-60 DAS and showed reduce towards maturity. The data exhibited that there was consistent increase in LAI of all the genotypes up to 60 DAS and sudden decrease LAI was noticed onwards. The mean LAI at 60 days after sowing was 1.40. The genotype AKM-1606 (1.73) was recorded the highest LAI after that BM-21-1 (1.70) and then BPMR-145 (1.62). The lowest leaf area index was observed in genotype AKM-1609 (1.18) at 60 DAS. The results of the present investigation confirm the earlier findings of Nanda and Saini (1988) [4] observed that in mungbean first trifoliate appeared 10-12 DAS and the crop attained the maximum leaf area index (LAI) on 50-55 DAS.

Chlorophyll content (SPAD Reading)

The data related on SPAD chlorophyll meter readings of greengram leaves at different stages were presented in fig.4. The treatment differences in all genotypes at all crop stage were found significant. The SPAD chlorophyll meter readings gradually increased from 20 to 60 DAS in the all genotypes. After 60 days sowing SPAD chorophyll meter readings in one of genotypes declined and in rest of the genotypes showed increase at harvesting stage. General mean of total chlorophyll content was highest (62.27) at harvest as compared to other stages. Mean total chlorophyll content at harvest was differed statistically significant in all genotypes. The genotype BM-21-1 (71.10) recorded highest chlorophyll content followed by BPMR-145 (67.22) and BM-2003-2 (67.10). Significantly lowest chlorophyll content was recorded in genotype AKM-1609 (48.47). It is observed that the genotype BM-21-1 recorded highest total chlorophyll content (71.10) among all the genotypes. Similar results were observed by Prakash *et al*. (2007) [6] he reported higher chlorophyll content in the genotype PLS-264.

Root and shoot biomass in mungbean genotypes

The data regarding mean shoot biomass and root biomass per plant as affected periodically by different genotypes are presented in figure 5 and 6 respectively. The differences amongst the varieties were significant at all the stages. The mean shoot biomass per plant was 0.20, 3.29, 8.91 and 11.68 g at 20, 40, 60 days after sowing and at harvest respectively. Also, the mean root biomass per plant was 0.050, 0.495, 0.890 and 1.248 g at 20, 40, 60 days after sowing and at harvest respectively. At harvest the root and shoot biomass was highest as compared to previous stages because of crop attained the physiological maturity and overall growth of plant get stoped. However numerically higher shoot biomass recorded in genotypes BM-21-1 (18.23 g) followed by BPMR-145 (16.18 g) and then in Phule M-402-2-1 (14.17 g). Lowest shoot biomass observed in genotype AKM-1609 (5.14 g). Likewise similar observation regarding root biomass were found highest in genotypes BM-21-1 (2.371 g) followed by Phule M-402-2-1 (1.747 g) and then in BPMR-145 (1.736 g). And lowest root biomass observed in genotype AKM-1609 (0.577 g) at harvesting stage. Kothari *et al*., 2023 [3] observed some vigna species/subspecies exhibited a higher dry root weight in the LP condition and remaining species revealed a decline in SDW in the LP condition.

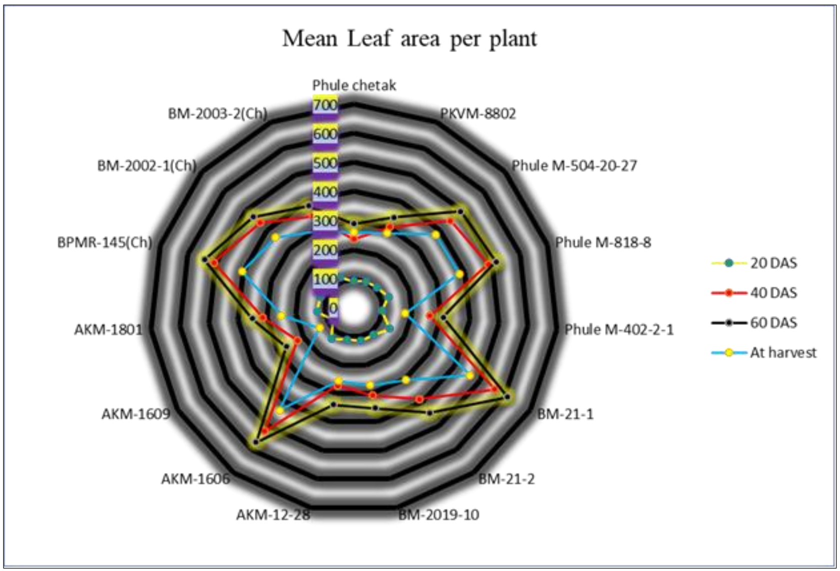

Fig 1: Radar with markers diagram of mean leaf area per plant (cm^2) of fifteen greengram genotypes on 20th, 40th, 60th DAS, and at harvest stage

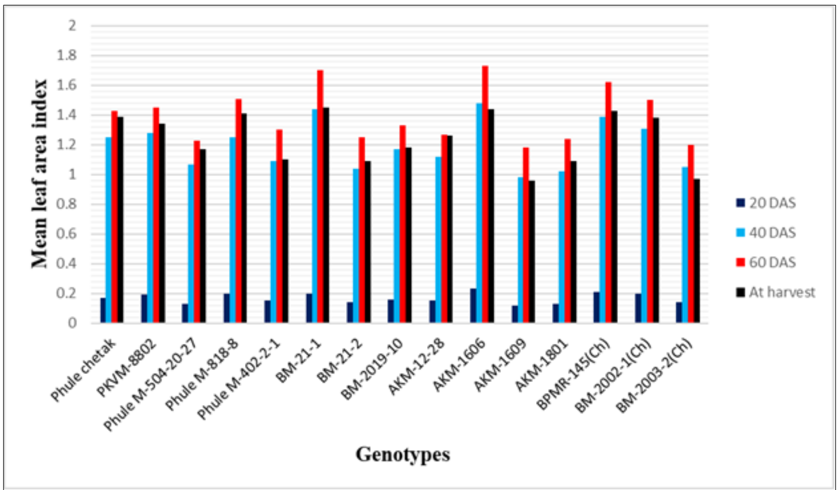

Fig 2: Clustered column diagram of mean leaf area index of fifteen greengram genotypes on 20th, 40th, 60th DAS, and at harvest stage

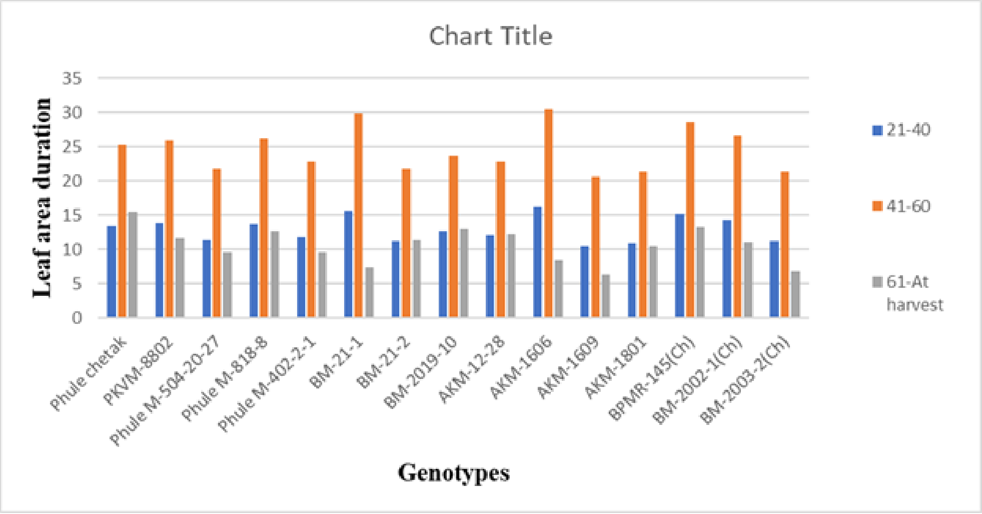

Fig 3: Line with markers chart of mean leaf area duration of fifteen greengram genotypes on 21-40 DAS, 41-60 DAS and 61- harvest stage

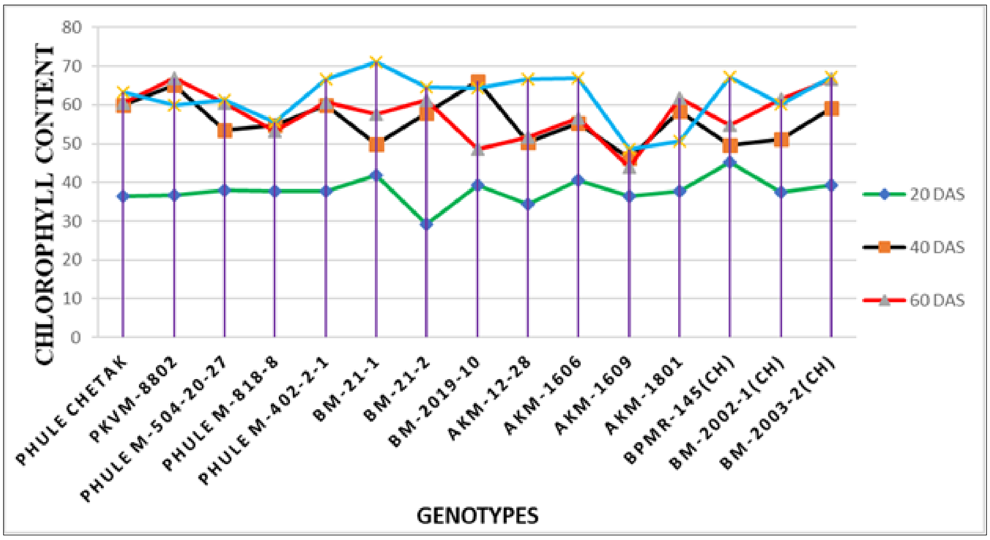

Fig 4: Line with markers chart of mean chlorophyll content of fifteen greengram genotypes on 21-40 DAS, 41-60 DAS and 61- harvest stage

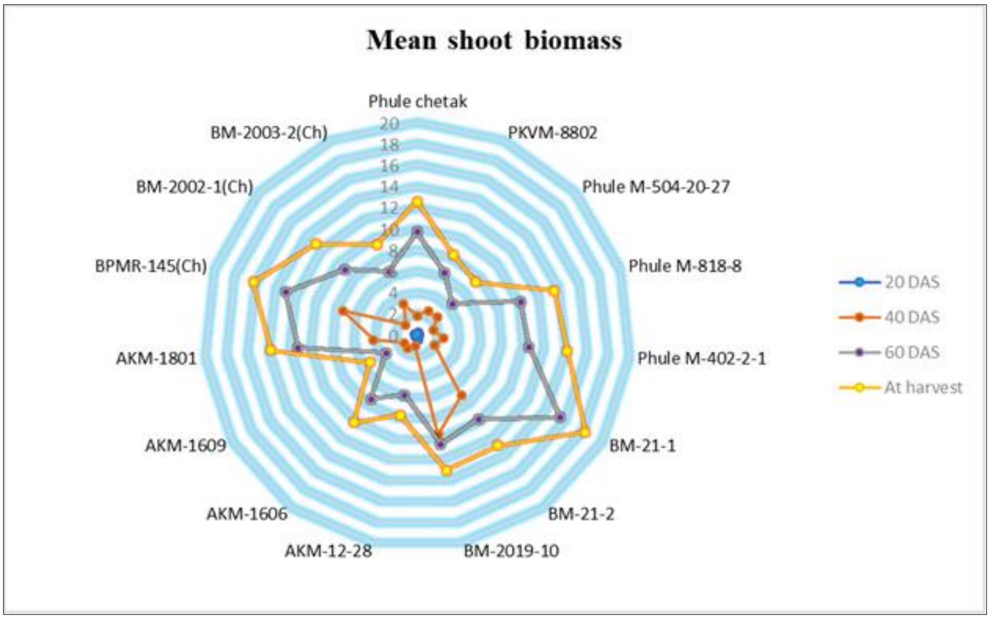

Fig 5: Radar with markers diagram of mean shoot biomass (g) of fifteen greengram genotypes on 20th, 40th, 60th DAS, and at harvest stage

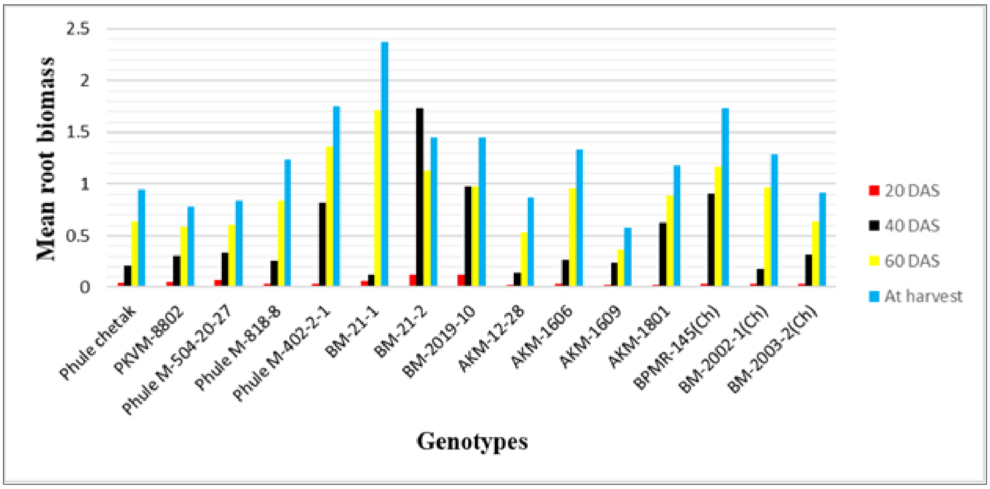

Fig 6: column diagram of mean root biomass (g) of fifteen greengram genotypes on 20th, 40th, 60th DAS, and at harvest stage

Conclusion

In conclusion, the comprehensive analysis of physiological parameters across fifteen mungbean genotypes has unveiled a considerable spectrum of variability. The distinct characteristics observed among these genotypes underscore the importance of genetic diversity in shaping mungbean's physiological attributes. Notably, the genotype BM-21-1 emerged as a frontrunner, displaying superiority in various morphological parameters, including the highest mean leaf area per plant, elevated chlorophyll content, and robust shoot and root biomass. Conversely, genotype Phule M-504-20-27 exhibited dominance in mean leaf area duration, highlighting its unique physiological profile. Additionally, the noteworthy performance of genotype Phule AKM-1606 in achieving the highest leaf area index further accentuates the diverse adaptive strategies employed by different mungbean genotypes. These findings not only contribute valuable insights into the inherent variations within mungbean populations but also underscore the significance of selecting and breeding genotypes with specific physiological traits to enhance overall crop performance and yield. As agriculture continues to face evolving challenges, harnessing the genetic potential revealed in this study may pave the way for more resilient and productive mungbean varieties, ensuring sustainable food production in diverse environmental conditions.

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