

**“Performance of Black gram (*Vigna mungo*  
(L.) Hepper) varieties under rainfed farming  
situation”**

**THESIS**

*Submitted to the*

**Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur**

**In partial fulfillment of the requirements for  
the Degree of**

**MASTER OF SCIENCE**

*In*

**AGRICULTURE  
(AGRONOMY)**

*By*

**VIVEK VERMA**

**Department of Agronomy**

**College of Agriculture, Rewa 486001**

**Jawaharlal Nehru Krishi Vishwa Vidyalaya,  
Jabalpur, Madhya Pradesh**

**2015**

## CERTIFICATE - I

*This is to certify that the thesis entitled “**Performance of Black gram (Vigna mungo (L.) Hepper) varieties under rainfed farming situation**” submitted in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE in Agriculture, (Agronomy)** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **Vivek Verma** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instructions.*

*All the assistance and help received during the course of the investigation have been acknowledged by him.*

Place: Rewa

Date:

**Dr. D. P. Dubey**

**Chairman of the Advisory Committee**

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Committee	Name	Signature
Chairman	Dr. D. P. Dubey	_____
Member	Dr. R. K. TIWARI	_____
Member	Dr. I. M. Khan	_____
Member	Dr. R. K. Tiwari	_____

## CERTIFICATE - II

*This is to certify that the thesis entitled “Performance of Black gram (Vigna mungo (L.) Hepper) varieties under rainfed farming situation” submitted by Mr. Vivek Verma to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of Master of Science in Agriculture, (Agronomy) in the Department of Agronomy has been, after evaluation, approved by the External Examiner and by the Student’s Advisory Committee after an oral examination on the same*

Place: Rewa

Date:

**Dr. D. P. Dubey**

**Chairman of the Advisory Committee**

### MEMBERS OF THE ADVISORY COMMITTEE

Committee	Name	Signature
Chairman	Dr. D. P. Dubey	_____
Member	Dr. R.K. TIWARI	_____
Member	Dr. I. M. Khan	_____
Member	Dr. R. K. Tiwari	_____

Head of the Department Dr. D. P. Dubey \_\_\_\_\_

Director of Instruction Dr. G. S. Rajput \_\_\_\_\_

## DECLARATION AND UNDERTAKING BY THE CANDIDATE

I, Vivek Verma S/O Shri Jagdish Chandra Verma Certify the work embodied in thesis entitled “Performance of Black gram (*Vigna mungo* (L.) Hepper) varieties under rainfed farming situation” is my own first hand bonafide work carried out by me under the guidance of Dr. D. P. Dubey at Department of Agronomy, College of Agriculture, Rewa, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur during 2014-2015.

The matter embodied in the thesis has not been submitted for the award of any other degree/diploma. Due credit has been made to all the assistance and help.

I, undertake the complete responsibility that any acts of misinterpretation, mistakes, errors of fact are entirely of my own.

I, also abide myself with the decision taken by my advisor for the publication of material extracted from the thesis work and subsequent improvement, on mutually beneficial basis, provided the due credit is given, thereof.

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Date:

**Dr. D. P. Dubey**

**Major Advisor**

**(Vivek Verma)**

**(Student)**

## ACKNOWLEDGEMENT

I would like to utilize this esteemed opportunity in remembering the Almighty God whose omnipresence has paved the way throughout my life.

It is a matter of great jubilation and privilege to express my deepest sense of ineptness and reverence to venerable **Dr. D. P. Dubey**, Chief Scientist, AICRPDA and Head of the department, Department of Agronomy, College of Agriculture, Rewa, Chairman of my advisory committee and most efficient, punctual and sagacious personality. I am highly thankful to him for keeping my moral high, being vigilant and providing valuable suggestions, without his help it would not have been possible to complete this irksome course of investigation.

I express equal gratitude and indebtedness from core of my heart toward members of my Advisory Committee namely, **Dr. R. K. Tiwari** Professor, Department of Agronomy, **Dr. I.M. Khan**, Professor and Head, Department of Plant Physiology, **Dr. R. K. Tiwari** Associate Professor, Department of Agronomy, for their able magnificent guidance inspiration and encouragement during the course of investigation and preparation of this manuscript. I am highly obliged to **Dr. B.M. Mourya** Principal Scientist, Department of Agronomy, **Dr. A.K. Jain** Senior Scientist, Department of Plant Pathology, **Dr. S.M. Kurmavanshi**, Senior Scientist, Department of Agronomy , **Dr. Gaurav Mahajan**, Assistant professor, Department of Agronomy and **Dr. V.D. Dwivedi** Technical Assistant, Department of Agronomy and **Mr. N. K. Jain** Technical Assistant, Department of Soil Science for their generous help, valuable suggestions, necessary help provided during the course of present investigation.

I am exceptionally thankful to **Dr. V. S. Tomar**, Honorable Vice Chancellor, JNKVV, Jabalpur, **Dr. G. S. Rajput**, Director of Instruction, JNKVV, Jabalpur and **Dr. S.K. Pandey**, Dean, College of Agriculture, Rewa, for extending the required facilities during the course of research work.

I express my deep gratitude to all the respected Professors of my College , **Dr. S. K. Tripathi**, Principle Scientist and Head of Department of Plant

Pathology and **Dr. S. K. Payasi** Senior Scientist, Department of Plant Breeding for their supportive attitude and valuable help during the course of investigation.

Above all, I am impassioned to register my abysmal humble love to my father Shri Jagdish Chandra Verma, mother Smt. Suman Verma who forever existing smile on my face have embraced all sort of pains, grief and worries that they came across. I felt as the "God" himself has incarnated in the form of my beloved parent and sister Bharti Verma, whose blessings are the sole cause my existence.

I wish to express my ardent appreciation and gratefulness to all my friends, shyam, Anil, Aarti Singh, Manish, Dhruv, Ajit, Pankaj, Sonal, Punit, Narendra, Rakesh, Akku, Akhilesh Chouhan, Vaishali, Bhavana, Jagdish Nagar, Dhanraj Patel, and seniors Vikram Pal, Devkishan Patidar, Sukhada Sharma, Anita Meena, Ashish Chourasiya, Preeti Tripathi, Neeraj soni and Juniors Pattu, Deepak, Lakhan and others whose constant support and generous co-operation were of enormous help in completion of my research work. At the end, from the core of my heart, I bow in my head in extreme regards the almighty god, whose blessings enabled me to reach this destination.

Place : Rewa

Date :

**(Vivek Verma)**

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## List of Abbreviations and Symbols

Abbreviation	Stand for
@	At the rate
&	And
ANOVA	Analysis of Variance
B:C ratio	Benefit : Cost ratio
Cm	Centimeter
C.D.	Critical difference
°C	Degree of centigrade
d.f.	Degree of Freedom
DAS	Days After Sowing
et al.	Et al (And other or co-worker)
Fig.	Figure
“F”	Fisher’s value
G	Gram
Ha	Hectare
HYV	High Yielding Variety
Kg	Kilogram
Max.	Maximum
M	Metre
Min.	Minimum
M.S.S.	Mean Sum of Squares
N	Nitrogen

NS	Non Significant
No.	Number
%	Percentage
P	Phosphorus
K	Potassium
Ph	Potential of Hydrogen ion
Q	Quintal
R	Replication
₹	Rupees
S.No.	Serial Number
*	Significant at 5 % level
S.V.	Source of Variation
SEm±	Standard error mean
S.S.	Sum of Square
i.e.	That is

## CURRICULUM VITAE

**VIVEK VERMA**

Vidhya nagar, Khargone

The.+ Dist.-khargone (m.p.) (451001)

Phone / Mobile No.:9165253373

Date of birth: 07/04/1990

Email id: vivekvrm2014@gmail.com

### Examinations passed from High school onwards:

Examination	Name of Exam	Name of the University or other examining body	Percentage of marks/ OCGA obtained	Division	Year of passing	Subject(s) (Major)
H.S.S.C.	12 <sup>th</sup>	M.P. Board Bhopal	69.77	I <sup>st</sup>	2008	Agriculture
UG	B.Sc. (Ag.)	J.N.K.V.V, Jabalpur (M.P.)	73.50	I <sup>st</sup>	2013	Agriculture
PG	M.Sc. (Ag.)	J.N.K.V.V. Jabalpur (M.P.)	77.00	I <sup>st</sup>	2015	Agronomy

For the partial fulfillment of the master's degree programme he was allotted a field research experiment on, "**Performance of Black gram (*Vigna mungo* (L.) Hepper) varieties under rainfed farming situation**" which was successfully conducted by him and being submitted in the form of this thesis.

Black gram (*Vigna mungo* L.) belongs to family Fabaceae sub family papilionaceae, is being grown as one of the principle pulse crop. In Madhya Pradesh is occupies in area of 0.64 Mha with the production and productivity of 0.26 MT and 413 kg/ha respectively. In india black gram is a grown in 3.11 Mha area with total production of 1.90MT and average productivity is 642 kg/ha (**Anonymous 2013**).

The most important states for pulses are Madhya Pradesh, Uttar Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Bihar which together account for 80%of total production. The decreasing per capita availability of pulses from 69 g in 1961 to 37 g in 2011 in the country has been a serious concern. To alleviate protein energy malnutrition, a minimum of 50g pulses/capita/day should be available in addition to other sources of protein such as cereals, milk, meat and eggs. India grow nearly 24 million hectare pulse crops and produce nearly 15.9 million tonnes of pulses grain, which is still deficit of the present consumption, i.e. 17.65 million tonnes (**Ali and Kumar, 2008**). They also stated that At least 29.30 million tonnes of pulses are required by 2020.

Blackgram is perfect combination of all nutrients, which includes proteins (25-26%), carbohydrates (60%), fat (1.5%), minerals, amino acids and vitamins. It stands next to soybean in its dietary protein content. It is rich in vitamin A, B1, B3 and has small amount of thiamine, riboflavin, niacin and vitamin C in it. It contains 78% to 80% nitrogen in the form of albumin and globulin. The dry seeds are good source of phosphorus. It also has very high calorie content. 100 gm of blackgram has 347 calories.

Despite of these features, the productivity of crop is below the average owing to several inherent soil related constraints such as low organic matter and poor soil fertility. Hence, it requires sincere efforts to enhance its productivity.

Blackgram thrives well under drought prone condition. However, there is a great variability for drought tolerance among blackgram genotype under drought

condition. Among different growth processes, seed germination and early seedling growth stages are considered critical for raising a successful agricultural crop, since they indirectly determine the crop density and consequently yield, especially under arid and semiarid condition. Different workers used different methods to evaluate genetic differences in drought tolerance but most of them have limited applications. In the present investigation attempts have been made to identify the suitable drought tolerant variety under rainfed conditions of this region.

In view of above background, the present research work “Performance of black gram (*Vigna munga* L.) varieties under rainfed farming situation”. Kymore plateau will be conducted with following objectives:

- 1) To study the growth and development of different black gram varieties under rainfed condition.
- 2) To identify the suitable black gram varieties for rainfed condition.
- 3) To find out the economics of different treatments.

Review of literature is a necessary step for any scientific study. It provides a theoretical framework, previous work and the basic interpretation of findings to the study. An attempt has been made to review the literature, which is meaningful and had direct relevance to this study. The available relevant references have been reviewed under this chapter are mentioned below:

Sharma et al. (1989) reported that sowing of four green gram cultivars on 13<sup>th</sup> July, 23<sup>rd</sup> July and 2<sup>nd</sup> Aug. gave seed yields of 0.87, 0.58, 0.41 and 0.17 t/ha respectively. Delay in sowing decreased 1000- seed weight and seed protein content. Cultivar ML. 131 gave the highest yield of 0.71 t/ha compared with 0.43-0.50 t in the other 3 cultivars. Cultivar Pusa Baisakhi had the highest 1000-seed weight of 30.3 g and protein content of 24.3%.

Laohasiriwarong (1991). reported that the genotype variance was largest for phenological traits such as number of days to first flowering. Sowing dates were the main cause of variation in the yield and number of seeds/ pod. As U Thong 1 did not differ significantly in yield from the highest- yielding variety (UT-7808) and was also ranked as a stable variety by all 3 methods used, it appeared suitable for the Khon Kaen area.

Mishra (1993) conducted field experiment on sandy loam soil on farmers field during the rainy seasons of 1986-87 at Sidhi, Madhya Pradesh where 3 black gram cultivars were given 0, 20, 40 and 60 kg P<sub>2</sub>O<sub>5</sub>/ha. This gave seed yields of 592, 655, 751 and 846 kg/ha, respectively. Cultivar RU-2, BP-1 and Local gave seed yields of 765, 739 and 635 kg/ha, respectively.

Parameswar and Setty (1993) evaluated six black gram varieties together with the local standard K-3 to study days to maturity, number of pods per plant Varieties LBG 642 and 2 BG 17 with respective mean yield of 1255 and 1222 kg/ha, significantly out yielded as compared to K3 (1083 kg/ha). LBG 642 recorded the highest number of pods per plant (15.5).

Sayao et al. (1993) found that among 25 mungbean varieties, VC 3012 B and VC 3301 A produced the highest seed yields (1.52 and 1.48 t/ha, respectively, compared with an average yield of 1.24 t/ha for all varieties). Nodulation was particularly high in VC4049-B-3-1-1-1-B (41 nodules/plant) and VC3061A (39.7 nodules/plant). Nodule dry weight per plant was greatest for cv VC2331A (75.2 mg.).

Borah (1994 a) sown five *Vigna radiata* varieties at seed rates of 20, 30 and 35 kg/ha during 1990 and 1992 and grown under rainfed conditions. These varieties differed significantly for 100- seed weight and seed yield in both years and for pods/plant in 1992 only. Seed rate also influenced yield significantly in both years. A consistent increase of seed yield was observed with increase in sowing rate. Variety- seed rate interaction effects were not significant.

Borah (1994 b) carried out field trial at Shilongani, Assam wherein yield among 6 black gram (*Vigna mungo*) cultivars ranged from 0.47 t/ha in TAU-5 to 1.51 t/ha in T-9, but was not significantly affected by row spacing (30 or 45 cm).

Chaudhary et al. (1994) reported that maximum height, number of branches, leaves as well as dry matter accumulation per plant were recorded in early (6<sup>th</sup> July) planted crop. However, variety WG 218 attained maximum height, trifoliolate leaves and dry matter per plant were associated with variety Type 9.

Jaiswal (1995) conducted trial by sowing of green gram cv. SML 32 and PDM 11 and black gram cv. Mash 218 and PDU 1 on 15<sup>th</sup> or 25<sup>th</sup> March or 5<sup>th</sup> April. The optimum sowing date recorded was March, cv. SML 32, PDM 11, Mash 218 and PDU 1 produced mean seed yields of 1.21, 1.42, 1.54 and 1.27 t/ha respectively.

Mandal and pal (1995) conducted a field trial at Jhargram (West Bengal) with 9 *Vigna mungo* cultivars and found that Pavit U 19 gave the highest yield per plant (2.22 g) followed by cultivar T 9 (2.21 g), B 76 (1.76 g) and PDM 87-14 (1.66 g.) Thus yield from the other cultivars were significantly lower.

Tomar and Tiwari (1996) reported from the field experiment conducted at Morena (M.P.) that the mean yield of green gram cultivars ranged from 698 kg per hectare in cv. PS -16 to 921 kg per hectare in K 851.

Reddy (1997) reported that the genotypic and phenotypic variation were highest for branches/plant followed by grain yield/plant and pods/plant. Days to maturity followed by plant height and pod length had the highest heritability's and were least influenced by the environment. Clusters/plant, pods/cluster, seeds/pod, 100-seed weight and grain yield showed high differences in phenotypic and genotypic variation, indicating that the expression of these traits was influenced by environmental components.

Selim (1999) conducted field trials during summer season of 1995 and 1996 at Beni-Swef Governorate, Egypt to evaluate productivity of six *Vigna radiata* genotypes (Kawmy-1, Giza-1, Vc-1000, Vc- 2719, T-44 and M- 53). Growth, yield and yield components as well as chemical analysis of seeds were studied. The highest seed yield per feddan (1088 kg/feddan) was obtained by Kawmy-1 followed by T-44 (1056 kg/feddan) and Vc-1000 (981 kg/feddan).

Singh et al. (1999) reported that cultivars UG 606 produced maximum seed yield followed by UG 841. The seed yield of recommended cultivars UG 414 and UG 218 was lower than UG 841 and UG 606.

Pandey and Singh (2000) concluded that early vegetative growth has no direct impact on grain yield and that plant height at and after flowering should receive attention as selection criteria. The results are contrary to the concept of competition between foliar development and grain, indicating that vigorous growth after anthesis should be encouraged. The correlation between total plant dry matter and grain yield was significant, while harvest index with grain yield showed no relation in either season. Further, the coefficient of determination shows that the contribution of total plant dry matter to grain yield was 50% in *kharif* season and 20% in summer season. These findings suggest that in order to attain maximum grain yield, vigorous plant growth is a pre-requisite.

Patra et al. (2000) found that blackgram variety 'Nayagarh Local' gave the maximum seed yield (978 kg/ha), followed by 'Sujata' (937 kg/ha) and 'PAM 54' (878 kg/ha). Sowing on 10<sup>th</sup> September was the best date with seed yield of 969 kg/ha. A delay of 10 and 20 days in sowing reduced the seed yield by 14.2 and 30.0% respectively. Most yield components varied significantly due to varieties but not due to dates of sowing. Incidence of yellow mosaic virus, cercospora leaf-spot and powdery mildew was the minimum in 'PAM 54' and in the crop sown on 10 September.

Madhavi et al. (2001) The study aims at examining the growth of germ tube of *Corynespora cassiicola* on leaves of different blackgram varieties viz., LBG 703, LBG 708, LBG 648, LBG 402, and LBG 17 at 15, 40 and 65 days age. The growth of the germ tube was less on the leaves of LBG 703 followed by LBG 708 but the growth was maximum on LBG 402 followed by LBG 17 at all ages of plants. Irrespective of the variety the growth of germ tube was more on the leaves of 65 days plants followed by 40-day and 15-day old plants.

Navgire et al. (2001) inoculated seeds of mung bean cultivars BM-4, S-8 and BM- 86 with *Rhizobium* strains M- 11-85, M- 6-84, GR-4 and M- 6-65 before sowing in the field experiment conducted in Maharashtra, S-8, BM-4 and BM-86 recorded the highest mean nodulation per plant (16.66), plant biomass (8.29 q/ha) and grain yield (4.79 q/ha) during the experimental years. S-8, BM-4 and BM-86 recorded the highest nodulation, plant biomass and grain yield when their seeds were inoculated with *Rhizobium* strains M-6-84, M-6-65 and M-11-85, respectively.

Patel and munda (2001) evaluated that the growth pattern and yield potential of five cultivars (T-9, PU-19, PDU-1, DPU-88-1 and DPU-88-31) of blackgram. Results showed high potential for blackgram cultivation. Plant height (42.2 and 41.6 cm), root length (20.1 and 19.3 cm), days to flowering (42.7 and 41.3) and maturity duration (84.3 and 84.7) were highest in DPU-88-1 for 1998 and 1999, respectively. DPU-88-31 recorded the lowest plant height (25.7 and 24.7 cm), days to 50% flowering (38.3 and 36.3) and maturity (82.7 and 81) respectively. The number of pods per plant was highest with T-9 (47.6) and lowest in PU-19 (33.3).

Highest number of seeds per pod, 1000-seed weight, seed yield per plant, biomass per plant and yield were recorded by PDU-1.

Santella et al. (2001) evaluated that the number of pods per plant, pod length, number of seeds per pod, 100- seed weight and yield ranged from 31.75 to 53.00, 7.48 to 9.58 cm, 8.59 to 9.85, 34.18 to 63.23 g and 1175.05 to 1815.05 kg/ha, respectively of blackgram.

Biswas et al. (2002a) evaluated the growth and yield performance of two blackgram varieties i.e., Barimash 3 and Barimash 1 under three different population densities. The planting configurations were 40 x 10 cm<sup>2</sup>, 30 x 10 cm<sup>2</sup> and 40 x 5 cm<sup>2</sup> representing 25, 33 and 50 plants m<sup>-2</sup>. Both the blackgram varieties showed identical results in LAI, CGR, NAR, RGR as well as grain yield. But planting density had significant effects on LAI and CGR of the blackgram varieties. The highest planting density showed the highest LAI and CGR but the highest grain yield was recorded from intermediate population density due to the highest number of pods per unit area. The NAR and RGR did not differ due to different population densities.

Bishwas et al. (2002b) conducted an experiment to determine the highest seed yield of different varieties of blackgram in region of Bangladesh and reported that Barimash 3, produced the highest seed yield (972 kg/ha) which was statistically similar to that of Baramashi (960 kg/ha). Baramas 2 produced the lowest seed yield (866 kg/ha).

Ghafoor et al. (2002) reported that the suitable and economically viable cultivation method of black gram. Among the treatment BARI Mash-2 and BARI Mash-1 that found was the highest grain yield BARI Mash-2 (1044 kg/ha) compare to lowest grain yield of BARI Mash-1 (475 kg/ha).

Mahalakshmi et al. (2002) studied the performance of 5 black gram genotypes (LBG 20, LBG 623, LBG 685, LBG 708 and LBG 709) under rainfed conditions in the field (on deep Vertisols) in Andhra Pradesh. LBG 708 was taller (43.5 cm) and had higher total biomass production (15 g/plant), number of leaves/

plant (12.4), number of branches per plant (7.0), leaf area index (5.62 dm<sup>2</sup>), nitrate reductase activity (65.0 moles of No<sub>2</sub>/h g<sup>-1</sup>), number of pods per plant (27), harvest index (28.5) and seed yield (10.3 q/ha) under rainfed conditions compared to the other genotypes.

Ahmad et al. (2003) concluded that mungbean cultivar NM-46-7-2 applied with 50-100 kg/ha NP, produce more number of grain per plant, 100- seed weight, grain yield and grain protein content than the other cultivars.

Parameswarappa and Lamani (2003) conducted experiments to evaluate the performance of 6 green gram cultivars (SEI-4, GMBL-1, GMBL-2, TM-97-55, SEL-3 and M-1), compared with 4 controls (Chaina Mung, PS-16, TAP-7 and Pusabaisaki), under rainfed conditions on medium black soil of the Northern Transitional Zone of Karnataka. Data for seed yield, plant height, pods per plant, test weight, days to flowering and days to maturity indicated that SEL-4 was the most suitable genotype for cultivation in the area.

Reddy et al. (2003) determined the performance of 13 blackgram cultivars (LBG 685, LBG 648, LBG 611, LBG 645, LBG 22, LBG 623, LBG 695, LBG 703, LBG 708, LBG 709, LBG 719, LBG 17 and LBG 402). LBG645 recorded the highest number of branches per plant (6.3), biomass production (4.80), number of pods per plant (11.4), seed yield (10.82 q/ha) and nitrogen reductase activity (51.80 nmol/h/g). LBG 703, LBG 685 and LBG 719 recorded the tallest plants (37.9 cm), highest number of seeds per pod (6.73) and harvest index (37.2).

Varma and Garg (2003) evaluated thirty two mungbean genotypes in Rajasthan. A high range was observed for plant height, pod number per plant, biological yield, harvest index and days to 50% flowering. Narrow range was observed for the characters 100-seed weight, seed yield per plant, pod length, seed number per pod and primary branch number per plant. Generally, the magnitudes of phenotypic coefficient of variation were higher than those of genotypic coefficient of variation for all the characters.

Dalley et al. (2004) observed that performance of yield attributing characters of green gram was significantly higher at 45 cm row spacing but the higher seed yield of the crop by 40-52 percent was obtained with 25 cm row spacing. This may probably increase plant population and subsequently lesser the weed interferes under cluser row spacing.

Vanniarajan et al. (2004) Accelerated ageing test was carried over in four rice fallow blackgram varieties viz., LBG 20, VBN I, ADT 3 and ADT 5. The seeds were subjected to 15% moisture content and stored at 45 C. Periodically seeds were taken out and subjected to observations like germination percentage, seedling vigour, speed of germination and electrical conductivity. The results revealed that VBN. 1 is good storer, have more viable and vigorous seeds as compared to others. The study was also indicated that electrical conductivity could be taken as an indicator of seed viability in blackgram.

Flores et al. (2005) characterized the agronomical behavior, yield components and its correlation to the yield in genotypes of the *Vigna* genera identified as JA-01-00-02, JA-01-00-02, JA-01-00-05, MEM-02-00-19, AM-02-00-016, MS-01-00-09 and the commercial variety "Tuy". Essays were carried out at Saman Mocho, Carabobo state and Maracay, Aragua state. The genotype that reached higher height of the plant was MEM-02-00-19. The variance analysis and the means test of Duncan detected significant differences for yield in Maracay. Materials with highest yield were of *Vigna unguiculata* species: MS -01-00-09 (2114.1 kg/ha) and JA-01-00-05 (1605.6 kg/ha). Pods of highest longitude and total seeds by pods were observed in MS-01-00-09 with 4.2 cm of longitude and total number of seeds per pods 10.9 seed/pods. In genotype of *Vigna unguiculata*, MEM-02-00-19 recorded the highest number of pods per plant 17.5.

Razzaque et al. (2005) conducted an experiment in a farmer's field at Patuakhali, Bangladesh, under rainfed condition. Four mungbeans (*Vigna radiata*) cultivars, namely BARImung-2, BARImung-3, BARImung-4 and BARImung-5, were sown at 15-day intervals from 1 January to 1 March in both years. Data were recorded for plant height, pods per plant, seeds per pod, 1000-seed weight and

seed yield. Plants sown on 15 February recorded the highest seed yield. Sowing thereafter drastically reduced seed yield. The highest seed yield of 1445 kg/ha (pooled over 2 years) was obtained from BARImung-5 sown on 15 February. Analysis of interaction effects showed that all cultivars, except BARImung-3, gave better performance under 15 February sowing.

Razzaque et al. (2005) reported that the plants sown on 15<sup>th</sup> February recorded the highest seed yield. Sowing thereafter drastically reduced seed yield. The highest seed yield of 1445 kg/ha (pooled over 2 years) was obtained from BARIMUNG-5 sown on 15<sup>th</sup> February. Analysis of interaction effects showed that all cultivars, except BARIMUNG-3, gave better performance under 15<sup>th</sup> February sowing.

Singh and Ahlawat (2005) studied that Greengram [*Vigna radiata* (L.) R. Wilczek] and blackgram [*V. mungo* (L.) Hepper] are widely cultivated in India in different seasons. In general, these crops are grown in rainfed condition. During the past 40 years, the area and production of these crops have shown a positive trend, and now these crops are no more considered as minor crops. This has been achieved primarily owing to the availability of short-duration, disease-resistant varieties which fit well in the different cropping systems. However, the productivity has shown a slow progress. To increase the yielding ability with added advantage of stability, crossing programme involving wild relatives and land races may be followed. The cultivation practices as well as varieties suitable for intercropping systems may be developed. There is a need to incorporate resistance against cercospora leaf spot (*Cercospora* spp), anthracnose [*Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi & Cav.]], pre-harvest sprouting, drought and heat tolerance. The integrated pest management (IPM) module (s) for different seasons and cropping systems may also be developed for these crops.

Singh et al. (2005) reported that the genotypes showed significant differences for grain and straw and N content and P content in grain while P content in straw, N and P uptake differed non-significantly. Phosphorus application resulted in significant increase in N and P content and their uptake by all three genotypes.

SML 134 recorded the significantly highest protein content among the genotypes. Protein content in the grains increased with subsequent increasing in the rate of phosphorous.

Ghose et al. (2006) studied on the response of moong cultivars (Asha, T-44, K-581, MH- 85) to different rhizobial strains (M- 1005, M-1006, M-11, M-20) in terms of number of nodules, nitrogen fixation and grain yield of moong in sandy loam soil under pot culture condition. Moong cultivars responded differently to rhizobial stains. Moong cultivars K- 581 and MH-85 were found more M- 1006 isolate. Asha cultivar was found to be responsive only to M- 1005 where as cv. T-44 showed good response to M-11. Interanction of cultivars with rhizobial strains showed that response of moong cultivars varied with rhizobial isolates.

Gupta and Sharma (2006) A field experiment was conducted during the rainy seasons of 2000 and 2001 on fanner's field at Kangra (HP), to study *the* effect of biofertilizer (PSB, two levels) and phosphorus fertilization (4 levels) on ylekJ and economics of blackgram (*Vigna mungo* L.).The study revealed that crop responded favourably to seed inoculation with PSB and phosphorus fertilization (60 kg P<sub>2</sub>O<sub>5</sub>/ha) in influencing seed yield. Mean values of two years showed that variety UG-218 was observed to give highest net return/ha and net return/rupee invested of Rs. 12,497 and Rs.7.5, respectively at its optimum dose, which was worked out to be 86.3 kg Pp/ha while with inoculation net return/ha and net return/rupee investment at optimum dose were higher over their respective uninoculated treatment.

Gupta et al. (2006) A field investigation was conducted at farmer's field during the rainy seasons of 2000 and 2001 to study the effect of bio-fertilizer inoculation and phosphorus fertilization on yield and quality of the cultivars of blackgram (*Vigna mungo* (L.) Hepper] 'UG 218' blackgram produced significantly higher pods/plants, 1,000-seed weight, seed yield as well as straw yield over other 2 varieties. However, the protein content was higher in the seeds of 'Type 9'. The practice of seed inoculation with phosphorus-solubilising bacteria showed a significant increase in seed yield and its attributes as well as protein content and N

and P uptake over uninoculated treatment. Response of crop to phosphorus fertilization was significant up to 60 kg P<sub>2</sub>O<sub>5</sub>/ha for seed and straw yields. Phosphorus application also resulted in significant increase in seed protein content and N and P uptake in seed and straw.

Rao et al. (2006) evaluated 180 germplasm lines of mungbean comprising both indigenous and exotic collections along with checks in augmented block design for yield and its components during *rabi* 2002-03. The checks were found to be superior to the test material for all the characters studied except for 100 seed weight. The ANOVA for yield indicated highly significant differences among test varieties and check. The traits plant height and number of clusters per plant recorded highly significant and positive association with grain yield, while number of seeds per pod showed negative association with seed yield.

Singh et al. (2006) concluded that six genotypes of mungbean namely IC-39535, IC-39429, IC-39358, IC-39447, IC-39283 and IC-39313 (check) in a randomized block design. The genotypes showed significant variations in plant height, branches per plant, pods per plant, seeds per pod, 100-seed weight, seed yield, biological yield and harvest index. IC-39358 followed by IC-39535 produced significantly higher seed yield than national check and rest of genotypes. Significantly higher number of pods and branches per plant mainly attributes toward increased seed yield in IC-39358 and IC-39535. In general short duration genotypes IC-39535, IC-39429 and IC-39283 in comparison to normal duration genotypes showed efficient biological yield and yield attributes which resulted in higher overall harvest index and seed yield.

Sharma et al. (2007) examined the different varieties of moongbean genotypes for their physio-chemical and cooking quality characteristics. ML-1270 (1.34 g/ml), ML-1191 and ML-1165 (1.32 g/ml each) and NM 92 (1.33 g/ml) had highest density. Water absorption and volume expansion was observed highest in ML-1191 (121.82% and 180.0%). Protein content was found highest in NM-92 (25.37%) followed by ML-1165, ML-1271 and ML-1299 (24.5% each). ML-1165 took minimum time (19 minutes) to cook. ML-1191 exhibited higher water absorption and

volume expansion after cooking (167.09% and 195.45%), followed by ML-1109 (159.55% and 150.00%) and ML-1260 (126.21% and 172.70%). Solid dispersion after cooking was also registered highest in ML-1109 (26.76%) and ML 1260 (21.37%).

Bhowmik et al. (2008) reported from Mushidabad (W.B) the genotype WBM 29 significantly yielded the highest (983.28kg/ha) and was followed by WBM 4-34-1-1 (869.90 kg/ha), the later matured earlier than the other including B1 (state check) and PDM 54 national check. Sowing on March resulted in higher growth and yield of all the genotypes excepting PDM 54, which performed better under growth and yield of all the genotypes excepting PDM 54, which performed better under sowing on first week of March.

Katiyar et al. (2008) carried out a study during 2004-06 on morphological characterization of greengram [*Vigna radiate* (L.)Wilezek] and establish distinctness of the candidate variety from all other varieties. A total of 73 released Indian cultivars of green gram were grouped for several agro-morphological descriptors. Wide diversity (38 to 70 cm) has been observed in plant height. Maximum varieties are of medium seed size (3-5 g/100-seed weight) except 'Pusa Vishal' and 'SML 668' (large seeded > 5 g/100 seed).

Malik et al. (2008) conducted studies on eighteen genotypes of black gram (*Vigna mungo*) to evaluate their comparative performance under rainfed conditions. Highly significant differences were observed for all the traits except leaf area which showed non-significant differences. Leaf area, pods/plant, plant height and biological yield/plant showed high genotypic and phenotypic variances exhibiting greater variability in these traits. The magnitude of heritability was high for 100-seed weight (94%), pods/plant (91%), pod length (91%), biological yield (87%), grain yield (85%), days to maturity (80%), harvest index (76%), branches/ plant (75%) and plant height (71%) indicating additive type of gene action. Pods/ plant, branches/plant and biological yield/ plant showed highly significant and positive correlation with grain yield showing that these traits have good positive effect on grain yield. Selection of genotypes on the basis of these traits can be useful. The

present study enabled to identify early to medium duration lines without losing grain weight and yield potential.

Sadeghipour (2008) reported that mungbean variety Partow, gave significantly higher number of pods per plant, number of seed per pod and seed yield than variety Barymung 2 and VC 638, against variety VC 6368 had higher 100-seed weight. The highest seed yield ( $243.39 \text{ g m}^{-2}$ ) was recorded in irrigation throughout the growing period by variety Partow and the lowest seed yield ( $32.77 \text{ g m}^{-2}$ ) was obtained where we stop irrigation at the flowering stage in VC 6368.

Sheoran et al. (2008) conducted a field experiment to study the performance of mung bean genotypes in relation to their nutritional requirement under rainfed conditions. Mung bean genotype SML-668 produced significantly higher seed yield with mean superiority of 52.9% compared to ML-613. The application of  $12.5 \text{ kg N} + 40 \text{ kg P}_2\text{O}_5/\text{ha}$  increased the seed yield by 4.3% compared to  $12.5 \text{ kg N} + 20 \text{ kg P}_2\text{O}_5/\text{ha}$ , which, in turn, recorded a significant yield increase of 15.4% over no fertilizer application (N0P0). The interaction effect of mung bean genotypes with nutrient combinations showed superiority of SML-668 by 50.5, 56.1 and 51.7% when fertilized with N0P0, N 12.5,P 20 and N12.5, P 40 kg/ha, respectively, compared to ML-613 under rainfed conditions. An incremental dose of  $20 \text{ kg P}_2\text{O}_5/\text{ha}$  could bring out yield advantage of only 3.2% and 6.2% for SML 668 and ML 613, respectively, supplemented with  $12.5 \text{ kg N} + 20 \text{ kg P}_2\text{O}_5/\text{ha}$ .

Anurag et al. (2009) reported that the seeds obtained from pods of 25 days after anthesis recorded maximum dry weight, vigour index mass and 100-seed weight. Both early and delayed harvest recorded reduced quality of seeds in this crop. The variety Asha was found to be most responsive for all the parameters studied for physiological maturity at 25 days after anthesis.

Gosami et al. (2009) found that significant variations were observed among the genotypes with respect to the physiological traits analysed at different stages of plant growth. Among the various parameters; stomata conductance, photosynthetic rate, transpiration rate, total leaf chlorophyll and leaf nitrate reductase activity were found significantly higher in high yielding genotypes. However, the high yielding

genotypes were found to possess lower seed protein as compared to medium yielding, low yielding genotypes and checks. Among the genotypes, M-446 and M-100 had higher seed yield and harvest index and identified as physiologically more efficient.

Kumar et al. (2009) reported that the sowing of summer mungbean on 25<sup>th</sup> March recorded significantly higher grain yield (1346 kg/ha) with 14% increase over the late sowing (10<sup>th</sup> April). Variation in seed rate also brought a significant difference in grain yield. The highest grain yield (1.384 kg/ha) was recorded with 40 kg/ha seed rate which was at par with the seed rate @ 35 kg/ha (1349 kg/ha) and significantly superior over the seed rates 25 kg/ha (1094 kg/ha) and 30 kg/ha (1224 kg/ha). Variety 'SML 668' gave the highest grain yield (1332 kg/ha) which was significantly higher than the 'Pusa Vishal' (1229 kg/ha) and 'Samrat' (1227 kg/ha).

Goswami et al. (2010a) reported that significant variations were observed among the genotypes with respect to the morphological traits, dry matter partitioning pattern and yield. Among the morphological traits, number of primary branches, trifoliolate leaves and root nodules was found significantly higher in high yielding genotypes. The high yielding genotypes were found to possess higher leaf dry weight, stem dry weight and total dry weight as compared to medium yielding, low yielding genotypes and checks. Among the genotypes, M-446 and M-100 had higher seed yield and other yield components and may be used as genetic source for improvement of yield potentials in greengram.

Goswami et al. (2010b) reported that among the different mungbean genotypes, Pratap, KM 5-168 and AAU-34 were identified as physiologically efficient genotypes with respect to higher seed yield and other yield components.

Katiyar et al. (2010) Morphological characterization of blackgram varieties is essential for their protection under Plant Variety Protection (PVP) legislation, because varietal testing for Distinctness, Uniformity and Stability (DUS) are the basis for granting protection of new variety under PPV&FR Act, 2001. Keeping this in view, a total of 46 released varieties of blackgram were grouped for various agro-

morphological descriptors. All the varieties showed similar expression for each character over the years depicting the stability of varieties. None of the attribute showed intra-varietal variation. On the basis of 21 descriptors, varieties were grouped into different categories for each character and may be used as reference varieties.

Singh et al. (2011) found that optimum planting density of mungbean is required for obtaining higher grain yield. Field investigations were undertaken at Punjab Agricultural University (PAU), Ludhiana, on a sandy loam soil and at Asian Vegetable Research Development Center (AVRDC), Taiwan on a sandy loam soil. At PAU, 40 plants  $M^{-2}$  at 25 x 10 cm spacing gave significantly higher grain yield than 33 plants  $m^{-2}$  at 30 x 10 cm spacing. Genotypes Pusa Vishal (selection from AVRDC material NM 92), SML 668 (selection from NM 94) and Pusa 9531 were on at par in the grain yield and were better than UPM 98-1 and MH 96-1. Pusa Vishal and SML 668 had significantly larger seed size compared to Pusa 9531 and MH 96-1. At AVRDC, 20 plants  $m^{-2}$  sown at 50 x 10 cm spacing was the optimum for achieving higher grain yield and at higher plant densities, the yield tended to decrease. Lodging score was higher under higher plant densities. Genotypes NM 92 and VC 3890-A were superior to NM 94 and SML 134 in grain yield. Interaction between genotypes and plant density was non-significant for grain yield and other characters at both the location.

Sital et al. (2011) reported biochemical components in two mung bean varieties (SML 668 and ML 1333) cultivated during summer and *kharif* seasons were compared. The biochemical constituents in mature seed coat, cotyledons and changes during seed development were evaluated. Seed coat constituents viz; cellulose, hemicellulose, lignin and phenols responsible for hardseededness were higher in ML 1333 than SML 668, and in both varieties sown during *Kharif* than in summer season, whereas the contents of seed cotyledonary biomolecules viz; proteins, total sugars, starch and lipids were lower in *kharif* than summer season affecting grain quality of seed. Crude protein, soluble protein, sulfur containing amino acids, albumins and storage protein-globulins were higher in developing seeds in both varieties sown in summer than *kharif* season showing seasonal effect

on seed protein quality. Within varieties, these parameters were higher in SML668 than ML1333.

Verma et al. (2011) reported that mungbean cv. HUM 12 gave significantly higher plant height, number of trifoliolate leaves/plant, number of branches/plant, dry matter accumulation/plant, pod length, number of pods/plant, number of seed/pods, 1000 grain weight, grain yield, harvest index, protein content uptake and protein yield (kg/ha) than K 851 and NDM 1.

Dodwadiya and Sharma (2012) reported that variety SML 668 gave the highest seed yield in both seasons, followed by Pusa Vishal and Pusa 9531. Zero tillage was more profitable in summer, while conventional tillage was the best practice in the rainy season. It is recommended to grow newly-released variety SML 668 during summer as well as rainy season for higher productivity and profitability.

Jayamani et al. (2012) A high yielding blackgram culture COBG 653 is a cross derivative of DU 2 x VB 20 and matures in 60 - 65 days. This culture recorded an average yield of 877 Kg/ha with a yield increase of 24 per cent over the national checks varieties LBG 402 and LBG 17 under All India Co-ordinated trials. This was released for cultivation during rabi season in south zone consisting of Tamil Nadu, Andhra Pradesh, Karnataka and Odisha. In the state trials, it recorded an average yield of 733 Kg/ha with a yield increase of 13.46 per cent over VBN (Bg) 4, 12.42 per cent over VBN (Bg) 5 and 16.86 per cent over CO 5. It has bold seeds with a mean 100 seed weight of 5.5 grams. It is determinate and has synchronized maturity. It has good batter qualities like high initial batter volume and volume after fermentation. The protein content is 23.8 per cent. It is moderately resistant to mungbean yellow mosaic virus (MYMV), stem necrosis and root rot diseases. It is tolerant to aphids, stemfly and spotted pod borer infestation. This variety was notified recently as per the reference S.O. 632(E) dt. 25.03.2011. It is best suited for cultivation during rabi season in Tamil Nadu.

Singh et al. (2012) A diverse set of 105 blackgram genotypes comprising of released cultivars, advance breeding lines of inter-varietal and interspecific origin,

local germplasm collections, the wild progenitor of cultivated blackgram (*Vigna mungo* var. *silvestris*) and 5 checks were evaluated for their pre-harvest sprouting (PHS) tolerance and other important agronomic traits. Analysis of variance revealed significant differences among the genotypes. Seed germination (%) in pods (SGP), which was used as a measure of PHS, ranged from 8.8 in *Vigna mungo* var. *silvestris* to 99.4 in PCPGR 8057 (a local collection from Uttarakhand hills). The character associations and direct and indirect effects provided a preliminary idea about various plant, pod and seed traits playing role in the governance of pre-harvest sprouting in blackgram. The information on the performance of some popular blackgram cultivars with respect to PHS tolerance has been generated and some genotypes with relatively low PHS have been identified. Comprehensive field evaluation, however, is required before these genotypes can be used in breeding programmes.

Gangwar et al. (2013) Grain yield of blackgram increased significantly with delay in planting upto March 20, while further delay beyond March 20 reduced the yield. Pant U 31 variety produced significantly higher grain yield than other varieties.

Kumar et al. (2013) The present investigation, which was carried out to find out screening criteria against salt stress under incubator conditions in blackgram during 1999 comprised 18 improved land races collected from diversity rich zones of Uttar Pradesh and from NBPGR, New Delhi along with four check varieties were used. The study revealed the possible selection criteria for salt tolerance to be a combination of high germination and radical length. A significant reduction in germination was found at salinity levels of 11.25 dS/m, but genotypes ShU 9503, ShU 9508, ShU 9518, ShU 9511, ShU-9532, Type 9 and PU 19 showed good capacity to germinate at this level. Most of these genotypes was also reduced at high salinity levels, ShU 9536, ShU 9511 and ShU 9519 gave better radicle length. Type 9, PLU 289 and ShU 9601 had high plumule radicle length ratio at various salt concentrations, indicating better salt tolerance over other genotype. Dry matter production was also reduced at high salinity levels and other genotype. Dry matter production was also reduced at high salinity levels and significant differences were

found among the genotypes for dry matter production. However, dry matter obtained under salt stress was not found to match with good germination. Judicious use of selection on the basis of good germination (above 70%) along with high plumule radicle length ratio (more than 1) under salt stress condition can give a base for standardization of techniques.

Bhowaland and Bhowmik (2014) reported that variety and date of harvest had significant influences on various crop characters and seed yield. The variety *Bina Mung 7* showed superiority in plant height, number of branches plant-1, number of effective pods and total pods plant-1 and number of seeds pod-1 over other two varieties resulting in highest seed yield of 1856 kg ha<sup>-1</sup>. Among the harvesting date treatments, H3 (three times harvest) was superior in relation to number of branches plant-1, number of effective and total pods plant-1, number of seeds pod-1, 1000-seed weight and plant population per m<sup>2</sup> compared to H1 and H2 treatments which resulting the highest seed yield of 1792 kg ha<sup>-1</sup>. In case of interaction effect of variety and date of harvest, V3H3 treatment combination showed superiority in crop characters and yield attributes and yield (1950 kg ha<sup>-1</sup>) of summer mungbean variety than any other treatment combinations.

Reddy et al. (2014) conducted for response of different varieties to climate vulnerabilities like floods and droughts. The demonstrations on improved cultivars along with the respective local checks were compared with the participating farmers. Reported that the improved varieties blackgram (LBG-645) and greengram (MGG-295) were found stable in rainfed environment. It was recorded that 25–35% higher yield and net returns compared to respective local checks and gave higher productivity and profitability under rainfed conditions.

Shanti et al. (2014) reported that the effect of salinity in irrigation water on germination, crop stand at different stages and yield of nineteen released and pre-release varieties of blackgram was studied. Saline water with different electrical conductivities (dSm<sup>-1</sup>) viz., control (best available water-BAW), 2 E.C., 4 E.C. and 6 E.C. was used as irrigation water for rabi blackgram crop in a non-saline sandy loam soil of Bapatla, Andhra Pradesh. It was important to observe that the different

salinity levels did not affect the germination percentage of varieties tested during the two years of study. The results indicated that at 2.0 EC level, variety LBG- 623 recorded highest mortality rate followed by LBG-727, 17, 22 and LBG-733. Lowest mortality levels of below 10% were recorded in LBG-20, 402, 611, 648, 685, 726, 730, 733, 738 and T-9. At 4.0 EC most of the varieties registered mortality rate between 20 and 50 percent, while at this E.C. varieties LBG-22, LBG-402 and LBG-738 recorded low mortality rates. At 6.0 E.C. (dSm-1) LBG-402 and LBG-738 maintained lower mortality values during both the years of study, while in other varieties the mortality rate was still higher. This indicated that in other varieties, considerable damage has been done at 4.0 EC level itself. During two years of study, there was significant variation in grain yields between all four treatments. The highest yields of seed were recorded in varieties LBG-733, 726, 738, 723 and 727 under BAW. In other salinity levels (2.0, 4.0 and 6.0 EC levels), LBG-738 performed better than all other varieties recording 9.89 q ha<sup>-1</sup>, 6.54 q ha<sup>-1</sup> and 5.2 q ha<sup>-1</sup>, respectively. Varieties LBG-648, LBG-708, LBG-723 and LBG-726 also performed commendably as compared to other varieties.

Singh and sharma (2014) conducted the experiment at Simbhaoli and identify stable genotype of mungbean under varying environment. Forty indigenous genotypes of mungbean collected from different institute/organizations were evaluated under eight artificially created environments for stability analysis for seed yield and its components. On the basis of stability parameters, genotypes KM 2194, KM 2224, KMU 41, KMU 42, and KMU 55 were identified as desirable for seed yield.

Souframanien et al. (2014) Twenty four black gram genotypes were analysed for sucrose and RFOs content with an intention of identifying genotypes with low RFOs content. Analysis of raffinose family oligosaccharides revealed significant variation ( $P=0.05$ ) among the black gram genotypes of the 24 genotypes analysed, higher sucrose content was recorded in TU-72 (32.87 mg/g seed meal) followed by TU-26 (27.25 mg/g seed meal). Verbascose was the major RFO followed by stachyose among the black gram genotypes studied. Ajugose was a minor sugar

followed by raffinose. The total RFOs concentration in black gram ranged from 26.64 to 61.57 mg/g with an average of 43.6 mg/g. The highest total RFOs content was observed in the genotype LBG- 17 (61.57 mg/g). Low content of total RFOs was observed in TU43-1 (26.64 mg/g). Wide variation was observed for individual RFOs such as raffinose, stachyose, verbascose, and ajugose, which ranged from 0.18 to 8.08 mg/g, 8.90 to 37.27 mg/g, 13.95 to 31.02 mg/g and 0.30 to 4.48 mg/g respectively. TU43-1 and LBG- 402 which recorded low content of total RFOs also showed lowest verbascose and stachyose content respectively. TU1-820- 1-5 recorded high verbascose (31.02 mg/g) with low stachyose (11.13 mg/g) and raffinose (0.18 mg/g) content. Significant correlation ( $P < 0.05$ ) was detected among the four individual oligosaccharides with the total RFOs ( $r = 0.53$ ,  $r = 0.77$ ,  $r = 0.63$ ,  $r = 0.56$ ). The low RFOs genotypes identified in this study are particularly valuable in developing new black gram varieties for food and feed with improved digestibility and functionality.

The present investigation entitled “**Performance of Black gram (*Vigna munga* L.) varieties under rainfed farming situation**” was carried out to evaluate the different varieties under the existing agro-climatic conditions of Kymore plateau and Satpura hills zone of Madhya Pradesh. The details of materials used in experimentation, procedures followed and techniques adopted during the course of investigation are described in this chapter. Climatic and edaphic conditions prevailed during the crop growth period have also been presented wherever necessary.

### 3.1 Experimental site

The present experiment was conducted during the *kharif* season of 2013-14 at the Research Field of AICRP for Dryland Agriculture, Kuthulia Farm J.N.K.V.V., College of Agriculture, Rewa (M.P.)

### 3.2 Physico- chemical properties of soil

In order to determine the textural class and fertility status of the field soil, the soil samples from 0 to 30 cm depth were collected randomly from different plots of the experimental field prior to fertilizer application. The composite soil samples were analysed for the various physico-chemical properties of soil. The results obtained have been presented in Table.3.1.

**Table 3.1: Physico – chemical properties of the soil.**

Properties	Constituents	Composition value	Method used
Physical			
	1. Clay (%)	35.60	International pipette method ( Piper, 1967)
	2. Silt (%)	39.30	
	3. Sand (%)	25.10	

Chemical			
	1. Organic carbon (%)	0.51	Walkley and Black method (1934)
	2. Available nitrogen (kg/ha)	232.40	Alkaline permagnate method (Subbaih and Asija, 1956)
	3. Available phosphorous (kg/ha)	10.60	Olsen's method (Olsen <i>et al.</i> , 1954)
	4. Available potassium (kg/ha)	229.50	Flame photo meter (Chappman and Pratt, 1961)
	5. Soil reaction (pH)	6.72	pH meter
	6. Electrical conductivity (dsm <sup>-1</sup> ) at 25 °C)	0.14	Solubridge method (Black, 1965)

### 3.3. Climatic conditions:

Rewa is situated in the North- Eastern part of Madhya Pradesh at 24<sup>0</sup>31' North latitude, 80<sup>0</sup>19' East longitude and 365.7 meter above mean sea level, it has sub-tropical climate. Hot and dry summer and cold –winter are the main characteristic features of this region. The minimum and maximum temperature occasionally reaches 8<sup>0</sup>C and 44<sup>0</sup>C respectively. Summer months are hot and May is the hottest month when temperature reaches upto 44<sup>0</sup>C. Winter months experience mild- cold with the lowest temperature touching 4<sup>0</sup>C during December-January. The annual rainfall of this tract ranges from 900 to 1200 mm which mostly occurs during July to September. The onset of monsoon is mostly expected by the end of June to beginning of July and cessation by September, most of the rainfall received during July and August months. The sunshine hours and other meteorological factors remained favourable for the growth of blackgram. The monthly rainfall, number of rainy days, temperature, humidity and bright sunshine hours for the entire crop season (June to October) are presented in Table 3.2 and exhibited through Fig 3.1.

The perusal of data reveals that the total rainfall received during the crop growth season (June to October, 2014) was 768.9 mm. The mean lowest

temperature 16.6°C was recorded in the month of October, whereas the maximum temperature 38.9°C was noted in month of June. Relative humidity was the highest 99% in the month of September.

**Table 3.2: Mean weekly Meteorological information during crop season Kharif 2014**

Standard meteorological week	Temperature (°C)		Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
26	39.8	26.3	80	48	20.7
27	36.5	23.3	100	65	28.3
28	33.8	24.6	95	70	-
29	35.2	22.6	90	60	75.0
30	34.7	23.9	96	60	110.5
31	30.3	24.1	96	72	-
32	31.8	20.6	100	73	65.3
33	33.5	21.3	100	62	77.5
34	35.6	21.6	97	56	-
35	31.3	24.0	98	72	55.6
36	30.3	20.7	100	64	20.5
37	29.9	20.6	99	70	-
38	32.6	21.9	100	80	117.2
39	34.7	20.6	97	72	135.5
40	32.6	18.7	100	74	26.5
41	33.5	15.6	96	64	25.2
42	33.3	17.2	97	72	-
43	30.7	15.1	96	62	-
44	30.2	16.7	98	74	-
45	29.6	15.3	100	72	45.3
46	29.3	14.2	99	60	-

**Source:** Meteorological Observatory, Kuthulia Farm, Rewa (M.P.)

### 3.4 Cropping history of the experimental field

The previous cropping history of the experimental plot in which the investigation was done is given in Table 3.3

**Table 3.3 Previous cropping history of the experimental field**

<b>Years</b>	<b><i>kharif</i> season</b>	<b><i>rabi</i> season</b>	<b><i>zaid</i> season</b>
2011-12	Soybean	Wheat	Fallow
2012-13	Soybean	Wheat	Fallow
2013-14	blackgram (Experiment)	-	-

**Table 3.4 Blackgram varieties and their origin place**

<b>Treatments</b>	<b>Variety</b>	<b>Source of origin of variety</b>
T <sub>1</sub>	TU 94-2	TNAU
T <sub>2</sub>	PDU 1	GVPDAT, Pant nagar
T <sub>3</sub>	PW 30	GVPDAT, Pant nagar
T <sub>4</sub>	TU 98-4	TNAU
T <sub>5</sub>	JU 2	JNKVV, Jabalpur
T <sub>6</sub>	JU 3	JNKVV, Jabalpur
T <sub>7</sub>	TU 10	TNAU
T <sub>8</sub>	TU 27	TNAU
T <sub>9</sub>	TU 47-6	TNAU
T <sub>10</sub>	TU 57	TNAU
T <sub>11</sub>	TU 136	TNAU
T <sub>12</sub>	IVU 466	TNAU
T <sub>13</sub>	DU 4	TNAU
T <sub>14</sub>	IVU 486	TNAU
T <sub>15</sub>	IVU 88-10	TNAU
T <sub>16</sub>	TU 17	TNAU

### 3.5 Details of the field experiment

The experiment consisted of sixteen cultivars of blackgram. The cultivars were obtained from JNKVV Jabalpur (M.P). All the cultivars of blackgram were tested in a randomized block design with 3 replications. The details of the treatments are given as below.

**Table 3.5 Treatments details**

<b>Treatments</b>	<b>Variety</b>	<b>Treatments</b>	<b>Variety</b>
<b>T<sub>1</sub></b>	TU 94-2	<b>T<sub>9</sub></b>	TU 47-6
<b>T<sub>2</sub></b>	PDU 1	<b>T<sub>10</sub></b>	TU 57
<b>T<sub>3</sub></b>	PW 30	<b>T<sub>11</sub></b>	TU 136
<b>T<sub>4</sub></b>	TU 98-4	<b>T<sub>12</sub></b>	IVU 466
<b>T<sub>5</sub></b>	JU 2	<b>T<sub>13</sub></b>	DU 4
<b>T<sub>6</sub></b>	JU 3	<b>T<sub>14</sub></b>	IVU 486
<b>T<sub>7</sub></b>	TU 10	<b>T<sub>15</sub></b>	IVU 88-10
<b>T<sub>8</sub></b>	TU 27	<b>T<sub>16</sub></b>	TU 17

### 3.6 Layout of the experiment

The experiment was laid out as per layout plan which is given in Fig 3.5

Design	:	R.B.D.
Number of treatments	:	16
Number of replications	:	3
Gross plot size	:	5.00 m×2.10 m
Net plot size	:	4.00 m×1.50 m
Row to row spacing	:	30 cm
Total plots in the experiment	:	48
Date of sowing	:	09-07-2014
Method of sowing	:	Line sowing
Seed rate	:	20 kg/ha

### **3.7 Field preparation**

The field was prepared by one ploughing with disc harrow and cross ploughing by cultivators. Planking was done after final field preparation to make soil friable and level field to insure proper germination.

### **3.8 Fertilizer application**

An uniform dose of 20 kg N/ha and 40 kg P<sub>2</sub>O<sub>5</sub> /ha were given through di-ammonium phosphate (DAP) to all the experimental plots. Fertilizers were placed in the furrows opened by Kudali at the time of sowing.

### **3.9 Seed treatment**

The required quantity of seeds were treated uniformly with thiram 75% W.P. @ 3.0 g/kg seed, followed by inoculation with *Rhizobium* culture @ 50 g/10 kg seed + phosphorus – solubilizing bacteria (PSB) @ 50 g /10 kg seed as per treatment. The inoculated seeds were dried on the shade up to 30 minutes and sown in prepared field.

### **3.10 Sowing and thinning**

The lines were marked at desired distance and shallow furrow were opened with the help of Kudali at 30 cm row distance for sowing of blackgram. The seeds were drilled manually in the furrows using the recommended seed rate @ 20 kg/ha. The sowing was done on 9<sup>th</sup> July, 2014. Thinning operation was done at 20 days after sowing to keep the plant to plant spacing of 10 cm.

### **3.11 Weeding operation**

Seasonal weeds were removed manually at 20 and 40 days after sowing to avoid their competition with the crop plants

### **3.12 Harvesting**

The harvesting of different genotypes of blackgram was done between 8 to 26<sup>th</sup> September, 2014. The crop was harvested on the basis of net plot size (4.00

m×1.50 m).it was harvested manually with the help of sickle. The produce was left in the respective plots in order to avoid mixing of bundles of different plots. Each bundle was labelled by numbered tag. The seeded pods were also collected and harvested produce was allowed to dry in sun for few days.

### 3.13 Threshing

Threshing was done between 10 to 28<sup>th</sup> September, 2014 by beating the produce plot wise with stick. After threshing the seeds were weighed in kilograms. The yield of straw/plot was calculated by subtractive the weight of seed from the total weight of the produce/plot.

### 3.14 Crop calendar

Date wise details of various cultural operations carried out from seed bed preparation to the harvesting of the crop are tabulated in Table 3.5

**Table 3.7 Operational calendar**

S.No.	Field operations	Date
1	Field preparation	07 <sup>th</sup> July, 2014
2	Layout of experiment	08 <sup>th</sup> July, 2014
3	Soil sample collection	08 July, 2014
4	Application of fertilizers	09 <sup>th</sup> July, 2014
5	Seed treatment and <i>Rhizobium</i> inoculations	09 <sup>th</sup> July, 2014
6	Sowing	09 <sup>th</sup> July, 2014
7	Thinning	20 <sup>nd</sup> July, 2014
9	Hand weeding at 20 days after sowing	30 <sup>th</sup> July, 2014
10	Hand weeding at 40 days after sowing	20 <sup>th</sup> August, 2014
11	Harvesting crop	14 <sup>th</sup> - 25 <sup>th</sup> September, 2014
12	Threshing of crop	16 - 28 <sup>nd</sup> September, 2014

### **3.2 Observations recorded**

#### **1. Pre harvest:**

1. Plant stand /m<sup>2</sup> at 15 DAS and at maturity
2. Plant height at 15 DAS interval and at maturity
3. Number of branches /plant at 30 and 60 DAS
4. Days of flower initiation
5. Number of days for 50% flowering
6. Days to maturity

#### **2. Post harvest:**

1. Number of pods/plant
2. Length of pods
3. Number of grains/pod
4. Number of grains/plant
5. Test weight
6. Grain yield kg/plot/ha
7. Straw yield kg/plot/ha
8. Harvest Index

#### **3. ECONOMICS OF THE TREATMENTS (Rs/ha):**

1. Cost of Cultivation
2. Gross return
3. Net return
4. B:C Ratio

Since it was not possible to study all the plants of experimental population at the successive stages of growth, hence only 5 plants in each plot were selected randomly and tagged properly for detailed studies such as growth parameters, root characters, phenological parameters and yield attributes.

### **3.3 Plant population**

The plant population/m<sup>2</sup> was recorded after complete germination at 15 DAS and maturity stage. An uniform plant spacing of 10 cm was maintained by thinning operation after germination

### **3.4 Growth parameters**

#### **3.4.1 Plant height**

The plant height was taken from the ground level to the top of the leaves. Five plants were selected randomly and tagged properly. The observation on the height were recorded at different successive stages of 15, 30, 45, 60 DAS and at maturity and then average was computed.

#### **3.4.2 Number of branches/plant**

The numbers of total branches of five randomly selected plants were counted at 30 and 60 DAS and then average was computed.

### **3.5 Phenological characters**

#### **3.5.1 Days to flower initiation**

When flowering was started then the number of days was counted i.e. from sowing to date of first flower initiated.

#### **3.5.2 Days to 50 percent flowering**

When flowering was started then the number of flowered plants per plot was counted in alternate days. At the time of 50% flowering stage, dates were recorded. Whenever, the flowering arised in 50% plants of the total plant population of each plot, the total days were counted i.e. from sowing to 50% flowering.

#### **3.5.2 Days to crop maturity**

When pods were started to mature, the plant number/plot were counted in alternate days. At the time of 100% pod-matured plants, the dates were recorded.

Whenever the pod matured plants arised upto 100% of the total plant populations of each plot, the total days were counted i.e. from sowing to 100% matured plants.

### **3.6 Yield attributes**

The observations on yield attributes of blackgram were recorded from 5 randomly selected plants at the time of harvesting.

#### **3.6.1 Number of pods/plant**

The total number of pods of five randomly- selected selected were counted and average was worked out to single plant.

#### **3.6.2 Pod length (cm)**

The lengths of the 10 pods were randomly selected from the total number of pods which were separated from the sampled plants. These were measured and the average was worked out to single pod.

#### **3.6.3 Number of seed/pod**

The total numbers of seeds were removed from 10 randomly-selected pods and total seed number was counted and average was worked out.

#### **3.6.4 Number of seed/plant**

The total numbers of seeds were removed from 10 randomly-selected plants and total seed number was counted and average was worked out.

#### **3.6.5 Test weight of 1000- seeds**

The seed sample from the produce of each plot was taken and counted 1000 -seeds and then its weight were recorded.

### 3.7 Yield parameters

#### 3.7.1 Seed yield

The blackgram plants were harvested from net plot and then threshed after the sun drying. The seed yield of net plot was recorded and then converted in to kg/ha by multiplying with conversion factor 1666.66 (based on net plot size).

$$\text{Yield q/ha} = \frac{10000 \times \text{seed yield kg/plot}}{\text{Net plot size (6.0 m}^2\text{) } \times 100}$$

#### 3.7.2 Straw yield

The produce after harvesting, were left in the field then tied the bundles of each net plot for sun drying. The straw yield of each net plot was obtained in kg/plot by subtracting the seed yield of the respective plot from the weight of these bundles and then converted into kg/ha by multiply with conversion factor 1666.66. The straw of the plant i.e. leaves and pod covers in these crops which were weighted after threshing in each plot.

#### 3.8.3 Harvest index

The seed recovery was calculated with the help of following formula was suggested by Nichiporovitch(1960).

$$\text{HI (\%)} = \frac{\text{Seed yield (q/ha)}}{\text{Total biological yield (q/ha)}} \times 100$$

Where,

$$\text{Biological yield} = \text{seed yield} + \text{straw yield}$$

### 3.9 Economics of treatments

The economics of various treatments was calculated by converting the total yield of the plot in to money value.

### 3.9.1 Cost of cultivation

The cost of cultivation was estimated on the basis of prevailing market rate of expenditure as given in Appendix II.

### 3.9.2 Gross monetary return

The gross monetary return was calculated by adding the cost of seed and cost of straw according to prevailing market rates, as given in appendix III.

Gross monetary return (Rs/ha) = Cost of seed (Rs/ha) + Cost of straw (Rs/ha)

### 3.9.3 Net monetary return

Net monetary return was obtained by subtracting the cost of cultivation from gross monetary return.

Net monetary return (Rs/ha) = Gross monetary return (Rs/ha) - Total cost of cultivation (Rs/ha)

### 3.9.4 Return per rupee invested (B: C ratio)

B: C ratio was calculated as per formula given below:-

$$\text{Return per rupees invested} = \frac{\text{Gross monetary return (Rs/ha)}}{\text{Total cost of cultivation (Rs/ha)}}$$

### 3.10. Statistical analysis

Various data collected and observation recorded during the course of investigation were analysed statistically by using analysis of variance technique appropriate to randomized block design and valid conclusion were drawn as suggested by Panse and Sukhatme (1978).

The treatment difference were tested for significance by 'F' test the data in which the treatment effects were significant, the appropriate standard error of mean and the critical difference (CD) were worked out at 5% level of significance.

**Table 3.8 Skeleton of analysis of variance**

Source of variation	Degree of freedom	Sum of squares	Mean sum of squares	“F” Calculated	“F” Tabulated at 5%
Replications	2				
Treatments	15				
Error	30				
<b>Total</b>	<b>47</b>				

The significant difference between means was determined by using critical difference.

$$S. Em. \pm = \sqrt{\frac{EMS}{r}}$$

$$SEd = \sqrt{\frac{2 \times EMS}{r}}$$

Where,

EMS = Error means sum of square

r = Number of replication

C.D. = SEd × t<sub>value at 5 % for error df 30</sub>

C.D. = S.E(D) × t

The chapter deals with the findings of the experiment entitled “**Performance of Black gram (*Vigna mungo* L.) genotypes under rainfed farming situation**” conducted during the *Kharif* 2014. The observations on the plant growth, phenological parameters, yield attributes and yield which were recorded have been tabulated, statistically computed and the same are presented here under the appropriate headings. The data on analysis of variance after statistical analysis are given in the appendix section. The results are illustrated with suitable graphs at the appropriate place.

### **Growth parameters**

#### **Plant stand/m<sup>2</sup>**

A optimum plant population for any crop is one of the major factors for securing higher productivity. Uniform and optimum plant per unit area is a pre-requisite for obtaining the higher precision when it is not variable factor or treatment under test. The data presented in Table 4.1 and depicted in Fig. 4.1 and the analysis of variance is shown in Appendix- III and IV reveal that the plant stand of different genotypes recorded at 15 days stage of growth was found to be non-significant. However, it ranged from 31.27/m<sup>2</sup> in case of TU 57 to 32.80/m<sup>2</sup> in case of PDU 1. The plant population at maturity stage was also found to be non significant. Accordingly, JU 2 and TU 47-6 recorded the maximum plant stand (29.17 and 29.13/m<sup>2</sup>), whereas the minimum plant stand (27.20/m<sup>2</sup>) was noted in case of TU 57.

**Table 4.1 Plant population/m<sup>2</sup> of different blackgram genotypes**

Tr. No.	Genotypes	Plant population/m <sup>2</sup>	
		15 DAS	At maturity
T <sub>1</sub>	TU 94-2	31.57	27.73
T <sub>2</sub>	PDU 1	32.80	27.93
T <sub>3</sub>	PW 30	32.40	27.67
T <sub>4</sub>	TU 98-4	31.63	29.10
T <sub>5</sub>	JU 2	32.33	29.17
T <sub>6</sub>	JU 3	31.87	28.10
T <sub>7</sub>	TU 10	32.23	28.73
T <sub>8</sub>	TU 27	32.33	27.93
T <sub>9</sub>	TU 47-6	32.73	29.13
T <sub>10</sub>	TU 57	31.27	27.20
T <sub>11</sub>	TU 136	32.53	28.13
T <sub>12</sub>	IVU 466	32.00	27.87
T <sub>13</sub>	DU 4	31.67	28.87
T <sub>14</sub>	IVU 486	31.80	27.80
T <sub>15</sub>	IVU 88-10	32.27	29.00
T <sub>16</sub>	TU 17	32.27	28.27
<b>SEm ±</b>		<b>0.382</b>	<b>20.667</b>
<b>CD ( P= 0.05)</b>		<b>NS</b>	<b>NS</b>

## **Plant height**

The progressive plant height recorded at 15 days after sowing (DAS) and at crop maturity are highlighted in Table 4.2 and depicted in Fig. 4.2 and the analysis of variance is shown in Appendix- V and VI.

The plant height, in general, was enhanced by more than five times in all the genotypes with the advancement of plant growth from 15 DAS upto maturity stage. The plant height ranged from 8.52 to 12.47 cm at 15 DAS and 46.42 to 67.94cm at maturity stage of blackgram.

The plant height among the 16 blackgram genotypes was found to differed significant extent at both the stage of observation. The genotype TU 17 attained significantly tallest plants over all the remaining genotypes at 15 DAS and at crop maturity (12.47 to 67.94 cm). This was followed by and at par with TU 27 (12.07 cm) at 15 DAS of observation. The significant differences in height were also recorded at maturity stage. The data were followed similar trend as at 15 DAS, the blackgram variety TU 17 obtained significantly higher values of plant height (67.94cm) over all other genotypes, but at par with TU 27, TU 94-2, IVU 466 and PDU 1 at maturity stage. Blackgram genotype TU 10 attained lowest plant height (8.52 and 46.42 cm) at 15 DAS and maturity stage respectively. The overall trends evidently indicate that the progressive increase in height among the genotypes was inconsistent. Secondly, there were significant variations in their height at both stage of observations.

**Table 4.2 Plant height of different blackgram genotypes**

Tr. No.	Genotypes	Plant height (cm)	
		15 DAS	At maturity
T <sub>1</sub>	TU 94-2	11.80	64.31
T <sub>2</sub>	PDU 1	11.51	62.75
T <sub>3</sub>	PW 30	10.03	54.68
T <sub>4</sub>	TU 98-4	10.08	54.95
T <sub>5</sub>	JU 2	9.50	51.78
T <sub>6</sub>	JU 3	9.00	49.05
T <sub>7</sub>	TU 10	8.52	46.42
T <sub>8</sub>	TU 27	12.07	65.76
T <sub>9</sub>	TU 47-6	10.96	59.71
T <sub>10</sub>	TU 57	11.28	61.49
T <sub>11</sub>	TU 136	10.90	59.42
T <sub>12</sub>	IVU 466	11.65	63.51
T <sub>13</sub>	DU 4	8.71	47.49
T <sub>14</sub>	IVU 486	9.09	49.56
T <sub>15</sub>	IVU 88-10	9.97	54.32
T <sub>16</sub>	TU 17	12.47	67.94
<b>SEm ±</b>		<b>0.198</b>	<b>1.864</b>
<b>CD ( P= 0.05)</b>		<b>0.571</b>	<b>5.383</b>

## **Branches/ plant**

The number of branches/plant was recorded in all the 16 blackgram genotypes at 30 and 60 days stages of plant growth. The data presented in Table 4.3 and depicted in Fig. 4.3 and the analysis of variance is shown in Appendix- VII and VIII reveal that the formation of branches per plant was varied significantly among the genotypes at both the stages of observation.

At 30 DAS, IVU 466 and PDU 1 genotypes produced significantly higher number of branches (3.67 and 3.50/plant) over most of the remaining genotypes. On the other hand, TU 10 genotype produced the lowest number of branches (1.33 /plant).

At 60 DAS, the production trend of branches among the different genotypes was the same as observed at 30 days stage. The genotype IVU 466 recorded higher number of branches (5.23 /plant) over the remaining genotypes followed by and at par with PDU 1 (5.18 /plant), TU 57 (5.12 /plant), TU 17 (5.07 /plant), TU 27, JU 3 and TU 47-6.. These genotypes were found significantly superior over most of the other genotypes. While the significantly lowest number of branches (2.31/plant) was produced by TU 10 genotype of blackgram. Data indicated that there was wide difference in respect to number of branches among the genotypes under experimentation.

## **Phenological parameters**

### **Days to flower initiation**

The data presented in Table 4.4 and depicted in Fig. 4.4 the analysis of variance is shown in Appendix- IX indicated that the days taken to flower initiation was deviated significantly among the genotypes.

The PW 30 attained significantly earliest flower initiation in 29.97 days over all other genotypes. This was followed by TU 98-4 (30.43 days) and TU 94-2 (30.72 days) genotypes. Similarly, the genotype TU 10 initiated flowering later in 36.37 days, which was followed by IVU 88-10 (36.28 days).

**Table 4.3 Number of branches/plant of different blackgram genotypes**

Tr. No.	Genotypes	Number of branches/plant	
		30 DAS	60 DAS
T <sub>1</sub>	TU 94-2	1.35	3.15
T <sub>2</sub>	PDU 1	3.50	5.18
T <sub>3</sub>	PW 30	2.22	3.11
T <sub>4</sub>	TU 98-4	2.22	4.20
T <sub>5</sub>	JU 2	2.64	3.92
T <sub>6</sub>	JU 3	2.22	4.68
T <sub>7</sub>	TU 10	1.33	2.31
T <sub>8</sub>	TU 27	2.40	4.81
T <sub>9</sub>	TU 47-6	2.77	4.67
T <sub>10</sub>	TU 57	3.39	5.12
T <sub>11</sub>	TU 136	1.87	3.03
T <sub>12</sub>	IVU 466	3.67	5.23
T <sub>13</sub>	DU 4	2.39	3.05
T <sub>14</sub>	IVU 486	1.35	3.26
T <sub>15</sub>	IVU 88-10	1.37	3.52
T <sub>16</sub>	TU 17	2.47	5.07
<b>SEm ±</b>		<b>0.136</b>	<b>0.259</b>
<b>CD ( P= 0.05)</b>		<b>0.392</b>	<b>0.748</b>

### **Days to 50% flowering**

The data presented in Table 4.4 and depicted in Fig. 4.4 the analysis of variance is shown in Appendix- X indicated that the days taken to attained 50% flowering was deviated significantly among the genotypes.

The PW 30 attained 50% flowering significantly earliest in 34.97 days over most of the genotypes, which was followed by and at par with TU 98-4 (35.43 days) and TU 94-2 (35.72 days) genotypes. Similarly, the genotype TU 10 initiated flowering later also resulted in latest 50% flowering in 41.38 days.

### **Days to maturity**

The days to maturity of different genotypes was found significant as revealed from the same Table 4.4 and depicted in Fig. 4.4 the analysis of variance is shown in Appendix- XI.

The genotype PW 30 matured significantly earliest in 62.47 days over all other genotypes. This was followed by TU 98-4 (63.68 days) and IVU 466 (65.00 days). Whereas, the genotypes TU 10 and TU 57 were mature too late in 78.69 and 74.68 days, respectively. The differences among these genotypes were found significant.

### **Yield attributing parameters**

#### **Number of pods /plant**

The formation of number of pods/plant was found to be significant among the blackgram genotypes as apparent from Table 4.5 and depicted in Fig. 4.5 the analysis of variance is shown in Appendix- XII.

The genotype IVU 466 was found to be significantly higher pod- producer (55.47 pods/ plant) out of the 16 genotypes under experimental test over all other genotypes except PDU 1 (54.07 pods/ plant). This was followed by TU 57 (53.40 pods /plant) and TU 17 (52.60 pods /plant). Blackgram genotype TU 10 produced the minimum number of pods (39.00 pods /plant).

**Table 4.4 Days to flower initiation, 50% flowering and maturity of different blackgram genotypes**

<b>Tr. No.</b>	<b>Genotypes</b>	<b>Days to flower initiation</b>	<b>Days to 50% flowering</b>	<b>Days to maturity</b>
T <sub>1</sub>	TU 94-2	30.72	35.72	66.66
T <sub>2</sub>	PDU 1	35.83	40.83	70.68
T <sub>3</sub>	PW 30	29.97	34.97	62.47
T <sub>4</sub>	TU 98-4	30.43	35.43	63.68
T <sub>5</sub>	JU 2	33.17	38.17	68.39
T <sub>6</sub>	JU 3	35.21	39.71	68.68
T <sub>7</sub>	TU 10	36.37	41.38	78.68
T <sub>8</sub>	TU 27	35.63	40.13	74.10
T <sub>9</sub>	TU 47-6	35.01	39.51	69.03
T <sub>10</sub>	TU 57	34.50	39.10	74.68
T <sub>11</sub>	TU 136	33.45	37.95	66.01
T <sub>12</sub>	IVU 466	35.77	40.27	65.00
T <sub>13</sub>	DU 4	36.06	40.56	65.31
T <sub>14</sub>	IVU 486	35.08	40.18	65.35
T <sub>15</sub>	IVU 88-10	36.28	40.87	76.43
T <sub>16</sub>	TU 17	35.52	40.62	65.34
<b>SEm ±</b>		<b>0.150</b>	<b>0.145</b>	<b>0.323</b>
<b>CD ( P= 0.05)</b>		<b>0.432</b>	<b>0.418</b>	<b>0.932</b>

### **Length of pods**

The pod length of different blackgram genotypes differed significantly as exhibited in the Table 4.5 and depicted in Fig. 4.5 the analysis of variance is shown in Appendix- XIII.

The genotype IVU 466 produced the maximum pod length upto 3.33 cm, being superior to most of the genotypes but at par with PDU 1 (3.23 cm), TU 57 (3.17 cm), TU 27 (3.10 cm) and TU 17 (3.09 cm). The significantly lowest pod length (2.10 cm) was measured in case of IVU 486 genotype as compared to most of the genotypes.

### **Number of grains/ pod**

The data presented in Table 4.6 and depicted in Fig. 4.6 the analysis of variance is shown in Appendix- XIV indicate that number of grains per pod was differed significantly in different genotypes of blackgram.

The genotype IVU 466 produced the maximum number of grains (4.13 grains/pod), being significantly higher to most of the genotypes, but followed by and at par with PDU 1 (4.10 grains/pod), TU 57 (4.07 grains/pod) TU 27 (4.03 grains/pod) and TU 17 (3.80 grains/pod). On the other hand, the significantly lowest number of grains (2.77 grains /pod) was obtained by TU 10 and DU 4 (2.80 grains /pod) genotypes over most of the genotypes.

### **Number of grains/plant**

The number of grains/plant was found to differ significantly among the sixteen genotypes of blackgram Table 4.6 and depicted in Fig. 4.6 and the analysis of variance is shown in Appendix- XV.

The genotype IVU 466 proved outstanding in the formation of significantly maximum number of grains (263.67 grains/plant) over all the remaining genotypes. However, this was followed by PDU 1 (221.13 grains/plant) and TU 57 (217.20 grains/plant). In contrast to these observations, the minimum numbers of grains (107.93 grains/plant) were formed in TU 10 genotype, which was followed by

112.13 grains /plant in case of DU 4 genotype and then 114.73 grains/plant in genotype JU 2. The remaining genotypes recorded the grain numbers in the intermediate range.

**Table 4.5 Number of pods/plant and length of pods of different blackgram genotypes**

Tr. No.	Genotypes	Number of pods/plant	Length of pods (cm)
T <sub>1</sub>	TU 94-2	45.22	2.17
T <sub>2</sub>	PDU 1	54.07	3.23
T <sub>3</sub>	PW 30	42.30	2.37
T <sub>4</sub>	TU 98-4	43.43	2.40
T <sub>5</sub>	JU 2	39.13	2.20
T <sub>6</sub>	JU 3	41.90	2.40
T <sub>7</sub>	TU 10	39.00	2.13
T <sub>8</sub>	TU 27	51.47	3.10
T <sub>9</sub>	TU 47-6	48.47	2.88
T <sub>10</sub>	TU 57	53.40	3.17
T <sub>11</sub>	TU 136	44.73	2.47
T <sub>12</sub>	IVU 466	55.47	3.33
T <sub>13</sub>	DU 4	40.95	2.17
T <sub>14</sub>	IVU 486	44.63	2.10
T <sub>15</sub>	IVU 88-10	45.50	2.12
T <sub>16</sub>	TU 17	52.60	3.09
<b>SEm ±</b>		<b>0.568</b>	<b>0.092</b>
<b>CD ( P= 0.05)</b>		<b>1.641</b>	<b>0.265</b>

**Table 4.6 Number of grains/pod, number of grains/plant and test weight of different blackgram genotypes**

<b>Tr. No.</b>	<b>Genotypes</b>	<b>Number of grains/pod</b>	<b>Number of grains/plant</b>	<b>Test weight (g)</b>
T <sub>1</sub>	TU 94-2	3.50	158.20	41.93
T <sub>2</sub>	PDU 1	4.10	221.13	51.27
T <sub>3</sub>	PW 30	3.17	133.90	36.33
T <sub>4</sub>	TU 98-4	3.13	136.07	39.50
T <sub>5</sub>	JU 2	2.87	114.73	33.43
T <sub>6</sub>	JU 3	3.00	125.73	33.50
T <sub>7</sub>	TU 10	2.77	107.93	32.93
T <sub>8</sub>	TU 27	4.03	207.60	52.37
T <sub>9</sub>	TU 47-6	3.53	171.20	48.47
T <sub>10</sub>	TU 57	4.07	217.20	50.97
T <sub>11</sub>	TU 136	3.27	145.93	42.47
T <sub>12</sub>	IVU 466	4.13	263.67	51.80
T <sub>13</sub>	DU 4	2.80	112.13	32.03
T <sub>14</sub>	IVU 486	2.90	129.40	33.07
T <sub>15</sub>	IVU 88-10	3.33	151.60	38.90
T <sub>16</sub>	TU 17	3.80	199.87	51.43
<b>SEm ±</b>		<b>0.130</b>	<b>11.365</b>	<b>0.573</b>
<b>CD ( P= 0.05)</b>		<b>0.375</b>	<b>32.799</b>	<b>1.665</b>

### **Test weight (1000-grains)**

The test weight of grains of all the 16 genotypes of blackgram was deviated significantly as evident from the same Table 4.6, depicted in Fig. 4.6 and the analysis of variance is shown in Appendix- XVI.

The data indicate that TU 27 genotype recorded higher test weight (52.32 g), being significantly superior to most of the remaining genotypes, but followed by and at par with IVU 466 (51.80 g), TU 17 (51.43 g) and PDU 1 (51.27 g). In contrast to these observations, the significantly lowest test weight only 32.03 g was noted in case of DU 4 genotype of blackgram. This was followed by TU 10 (32.93 g) and IVU 486 (33.07 g).

### **Productivity parameters**

#### **Grain yield kg /ha**

The data presented in Table 4.7 and depicted in Fig. 4.7 the analysis of variance is shown in Appendix- XVII exhibit that all the sixteen genotypes of blackgram differed significantly in productivity.

Out of 16 genotypes, IVU 466 was found highest yielder (1169 kg/ha), being significantly superior to most of the other genotypes under test, but followed by and at par with PDU 1 (1158 kh/ha), TU 57 (1132 kg/ha) and TU 17 (1123 kg/ha). The significantly lowest yield (763 kg/ha) was obtained by TU 10 which was followed by and at par with DU 4 (792 kg/ha). The productivity of the remaining genotypes was found in the intermediate range.

#### **Straw yield kg/ha**

The straw yield per hectare was found to influence significantly due to different genotypes of blackgram as revealed from the same Table 4.7, depicted in Fig. 4.7 and the analysis of variance is shown in Appendix- XVIII.

Among the genotypes, IVU 466 produced significantly higher straw yield (1559 kg/ha) over most of the genotypes, which was followed by and at par with TU 17 (1531 kg/ha), PDU 1 (1497 kg/ha) and TU 57 (1453 kg/ha). On the other hand,

the lowest straw (985 kg/ha) was produced by JU 2 genotype, being significantly lower to most of the remaining genotypes and followed by DU 4 (1006 kg/ha). The remaining genotypes produced straw in the intermediate range.

**Table 4.7 Grain yield, straw yield and harvest index of different blackgram genotypes**

Tr. No.	Genotypes	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
T <sub>1</sub>	TU 94-2	1080	1394	43.65
T <sub>2</sub>	PDU 1	1158	1497	43.62
T <sub>3</sub>	PW 30	872	1109	44.00
T <sub>4</sub>	TU 98-4	968	1261	43.41
T <sub>5</sub>	JU 2	792	985	44.56
T <sub>6</sub>	JU 3	834	1096	43.21
T <sub>7</sub>	TU 10	763	1010	43.02
T <sub>8</sub>	TU 27	1103	1394	44.19
T <sub>9</sub>	TU 47-6	1099	1421	43.60
T <sub>10</sub>	TU 57	1132	1453	43.79
T <sub>11</sub>	TU 136	913	1145	44.37
T <sub>12</sub>	IVU 466	1169	1559	42.87
T <sub>13</sub>	DU 4	792	1006	44.04
T <sub>14</sub>	IVU 486	990	1330	42.67
T <sub>15</sub>	IVU 88-10	948	1381	43.85
T <sub>16</sub>	TU 17	1123	1531	42.31
<b>SEm ±</b>		<b>21.797</b>	<b>43.887</b>	<b>0.063</b>
<b>CD ( P= 0.05)</b>		<b>62.956</b>	<b>126.756</b>	<b>0.182</b>

## **Harvest index**

The harvest index of sixteen blackgram genotypes was found to deviate significantly as revealed from the same Table 4.7 and depicted in Fig. 4.7 the analysis of variance is shown in Appendix- XIX.

The genotype JU 2 was recorded highest harvest index (44.56%), which was significantly higher over all other genotypes except Tu 136 (44.37%). This was followed by TU 27 (44.19 %) and DU 4 (44.04%). The lowest harvest index was noted in case of TU 17 (42.31 %) which was followed by IVU 486 (42.67%).

## **Economical Studies**

The economic analysis consists with cost of cultivation, gross return, net return and benefit: cost ratio. The data are summarized in Table 4.8, presented in Figure 4.8 and depicted in Appendices I and II.

### **Cost of Cultivation**

Cost of cultivation was not differed between different genotypes. Among the 16 genotypes tested, the expenditure incurred on cultivation was Rs 16042/ha.

### **Gross monetary return**

Among the different genotypes IVU 466 led to record the highest gross monetary return (Rs. 48332 /ha) followed by PDU 1 (Rs. 47830 /ha) and TU 57 (Rs. 46719 /ha). The minimum gross monetary return was obtained by TU 10 (Rs 31517 /ha).

### **Net monetary returns**

The net return values differed between different genotypes. Among the genotypes, IVU 466 led to record the highest NMR (Rs. 32290 /ha) followed by PDU 1 (Rs. 31788 /ha) and TU 57 (Rs. 30677 /ha). The minimum net monetary return was obtained by TU 10 (Rs 15475 /ha).

**B: C ratio**

The maximum benefit: cost ratio was found with genotype IVU 466 (3.01) followed by PDU 1 (2.98) and TU 57 (2.91). The minimum benefit: cost ratio was recorded in TU 10 (1.96).

**Table 4.8 Economics of different blackgram genotypes**

Tr. No.	Genotypes	Gross return (Rs/ha)	Cost of Cultivation (Rs/ha)	Net return (Rs/ha)	B: C ratio
T <sub>1</sub>	TU 94-2	44608	16042	28566	2.78
T <sub>2</sub>	PDU 1	47830	16042	31788	2.98
T <sub>3</sub>	PW 30	35976	16042	19934	2.24
T <sub>4</sub>	TU 98-4	39968	16042	23926	2.49
T <sub>5</sub>	JU 2	32652	16042	16610	2.04
T <sub>6</sub>	JU 3	34470	16042	18428	2.15
T <sub>7</sub>	TU 10	31517	16042	15475	1.96
T <sub>8</sub>	TU 27	45527	16042	29485	2.84
T <sub>9</sub>	TU 47-6	45367	16042	29325	2.83
T <sub>10</sub>	TU 57	46719	16042	30677	2.91
T <sub>11</sub>	TU 136	37679	16042	21637	2.35
T <sub>12</sub>	IVU 466	48332	16042	32290	3.01
T <sub>13</sub>	DU 4	32673	16042	16631	2.04
T <sub>14</sub>	IVU 486	40930	16042	24888	2.55
T <sub>15</sub>	IVU 88-10	39314	16042	23272	2.45
T <sub>16</sub>	TU 17	46465	16042	30423	2.90

Blackgram, being one of the most important pulse crops of Madhya Pradesh, requires scrutiny of the genotypes for their suitability under the existing agro-climatic conditions of Satapura Plateau. Thus, it was important to identify their production potential in addition to their growth behaviour, yield attributes, maturity period including economical grain per hectare under rainfed conditions. Looking to facts as above all these parameters were recorded in the field and laboratory and these were presented in the results chapter. In this chapter, the findings of the present investigation have been interpreted and discussed in the light of the similar research work carried out by other workers in India and abroad. The discussion is confined to the relevant topics *viz.* crop stand, growth and phenological parameters, yield – attributes, yield and net income per hectare from 16 blackgram genotypes.

**Plant stand/m<sup>2</sup>**

The uniform plant population per unit area is an important factor to secure better growth and higher productivity. Seed viability, its germination and emergence is likely to differ from genotype to genotype because of their genetic variability. At 15 DAS as well as at maturity stage, the differences in plant population /m<sup>2</sup> were found to be non-significant in different genotypes. It ranged from 31.27 to 32.80 plants /m<sup>2</sup> at 15 DAS and 27.20 to 29.17 plants /m<sup>2</sup> at maturity stage among all the 16 genotypes.

**Growth parameters**

Almost a linear increase in plant height was observed with the advancement from 15 DAS to maturity of all the blackgram genotypes. The height of all the blackgram genotypes increased upto maturity. The fast increase in plant height in the early stage of plant growth may be attributed to the higher number of leaves producing higher food material for growth of the plant. In fact more and large sized leaves were responsible for preparing more food photosynthates which increased cell division and resulted in rapid growth of the plants. The later stage of plant

growth, plant height became slow which may be due to the fact that plants started entering from vegetative to the reproductive phase of growth and development and the dry matter accumulation were concentrated in reproductive parts of plant.

The plant height among the 16 blackgram genotypes was found to differed significant extent at both the stage of observation. The genotype TU 17 attained significantly tallest plants over all the remaining genotypes at 15 DAS and at crop maturity (12.47 to 67.94 cm). This was followed by and at par with TU 27 (12.07 cm) at 15 DAS of observation. The significant differences in height were also recorded at maturity stage. The data were followed similar trend as at 15 DAS, the blackgram variety TU 17 obtained significantly higher values of plant height (67.94 cm) over all other genotypes, but at par with TU 27, TU 94-2, IVU 466 and PDU 1 at maturity stage. Blackgram genotype TU 10 attained lowest plant height (8.52 and 46.42 cm) at 15 DAS and maturity stage respectively.

The significant variations in plant height among the sixteen genotypes may be due to their genetic variability for this trait. The similar results have also been reported by Selim (1999), Madhavi et al. (2001), Patel and munda (2001), Mahalkshmi et al. (2002), Reddy et al. (2003), Singh et al. (2006), Bhowmick et al. (2008), Goswami et al. (2010) and Verma et al. (2011).

Branching is an important character of crop which is directly related with the number pods formation per plant and ultimately the productivity of crop. All the 16 genotypes were found to differ significantly at 30 and 60 DAS with respect to formation of branches per plant. At 30 DAS, IVU 466 and PDU 1 genotypes produced significantly higher number of branches (3.67 and 3.50/plant) over most of the remaining genotypes. At 60 DAS, the production trend of branches among the different genotypes was the same as observed at 30 days stage. The genotype IVU 466 recorded higher number of branches (5.23 /plant) over the remaining genotypes followed by and at par with PDU 1 (5.18 /plant), TU 57 (5.12 /plant), TU 17 (5.07 /plant), TU 27, JU 3 and TU 47-6. These genotypes were found significantly superior over most of the other genotypes. While the lowest number of branches was produced by TU 10 genotype of blackgram at both the stage of observation.

The wide differences among the 16 blackgram genotypes with respect to branches formation may be owing to inheritance of genetic divergence of the genotypes. The present findings have been supported by many workers Mahalashmi et al. (2002), Parameswarappa and Lamani (2003), Reddy et al. (2003), Singh et al. (2006), Goswami et al. (2010), Verma et al. (2011).

### **Phenological parameters**

Earliest crop maturity is the desirable trait without any reduction in yield of high yielding varieties. In view of this fact, phenological studies of the newly developed genotypes, having most desirable features, has got its own importance.

Out of 16 blackgram genotypes, PW 30 attained earliest days to flower initiation (29.97 days), 50 % flowering in 34.97 days and finally crop maturity in 62.47 days. The genotype which matured one day late matured in 63.68 days was TU 98-4. Contrary to this, the genotype TU 10 takes maximum 36.37 days to flower initiation, 41.38 days to 50% flowering, thereby crop maturity became late by sixteen days (78.68 days).

Variation in the phenological parameters among the genotypes of blackgram reflects the fact there were wide differences in the duration of vegetative growth, thereby duration in the reproductive phase which are genetically controlled. Such type of variability is likely to persist with the effort of genetic advancement for aquaring desirable traits with the existing parent materials. The variation in phenological parameters among the genotypes have been reported by Patel et al. (2001), Reddy (1997), Pandey and Singh (2000), Verma and Garg (2003), Parameswarappa and Lamani (2003).

### **Yield attributing parameters**

Amongst the 16 genotypes of blackgram, IVU 466 brought about most of the yield attributes upto almost maximum extent i.e. 55.47 pods/plant, 3.33 cm length of pods, 4.13 grains/pod and 263.67 grains/plant. The 1000 grain weight (52.37g) was maximum in case of TU 27. The overall trend reveals that none of the genotype was found highest or lowest in the entire yield attributes. Thus, wide variations in yield

attributing parameters persisted among the different genotypes obtained from the different parental origin. Attainments of particularly higher or lower yield attributing character among the different genotypes are the genetically controlled phenomenon. Such variations in yield attributes among the blackgram genotypes have also been observed by several research workers, Selim (1999), Santella et al. (2001), Mahalashmi et al. (2002), Ahmad et al. (2003), Gupta et al. (2006), Singh et al. (2006), Bhowmick et al. (2008) Verma et al. (2011), Bhowaland and Bhowmik (2014).

### **Productivity parameters**

Amongst the 16 genotypes of blackgram, IVU 466 produced the significantly higher grain yield up to 1169 kg/ha as well as straw yield up to 1559 kg/ha. The maximum (44.56 %) harvest index was recorded with JU 2. The second best genotype in respect to grain yield was PDU 1 and straw yield was in TU 17. The higher productivity parameters in these genotypes might be due to higher yield attributing characters as compared to other genotypes.

The increased harvest index in these genotypes might be owing to production of higher grain over its straw. Different blackgram genotypes exhibited great variations in the productivity parameters. For example, grain yield ranged from lowest (763 kg/ha) in case of TU 10 to highest (1169 kg/ha) in case of IVU 466. The straw yield ranged from 985 kg/ha to 1559 kg/ha in the different genotypes. The harvest index ranged from 42.31 to 44.56% among the different genotypes.

Such a wide variations in the productivity parameters among the different blackgram genotypes have also been observed by many research workers Selim (1999), Santella et al. (2001), Ghafoor et al. (2002), Mahalakshmi et al. (2002), Ahmad et al. (2003), Gupta et al. (2006), Singh et al. (2006), Bhowmick et al. (2008), Verma et al. (2011), Gangwar et al.(2013), Bhowaland and Bhowmik (2014) and Reddy et al. (2014).

## **Monetary gain**

Maximum net monetary return per hectare is the main aim of any crop producer. The gross and net monetary returns were estimated for each genotype under test. Among the blackgram genotypes, IVU 466 proved highly profitable giving net income upto ₹ 32290/ha with B: C ratio upto 3.01. The other best genotypes were PDU 1 and TU 57, which gave net income upto ₹ 31788/ha and ₹ 30677 with B: C ratio 2.98 and 2.91, respectively. The higher monetary gain from these three genotypes was due to their higher grain and straw yields per hectare which fetched higher market price. On the other hand, the genotypes like TU 10 recorded lowest net income (₹ 15475/ha) with B:C ratio 1.96 only. This was due to lowest grain and straw yields per hectare. The present findings corroborate with those of other workers as reported earlier in case of productivity parameters. Because of variable yields from different genotypes, the variable net income was observed.

## ***Chapter 6* SUMMARY, CONCLUSION AND SUGGESTIONS**

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### **SUMMARY**

Increase in grain yield of blackgram can be achieved by the adoption of suitable variety accompanied by improved agronomic practices. Varieties play a viable role in maximization of yield by improving the fertilizer use efficiency, water use efficiency and cultural practices. The genetic potential of variety limits the expression of its yield and effects the plant growth in response of environmental conditions. Hence, the present experiment entitled “**Performance of Black gram (*Vigna mungo* L.) varieties under rainfed farming situation**” was conducted at all India Coordinated Research Project for Dryland Agriculture, Kuthulia Farm, College of Agriculture, Rewa (M.P.) during *kharif* season of 2014 the following objectives:

- 4) To study the growth and development of different black gram varieties under rainfed condition.
- 5) To identify the suitable black gram varieties for rainfed condition.
- 6) To find out the economics of different treatments.

The soil of the experimental field was clay loam having pH 6.72, electrical conductivity 0.14 ds/m, organic carbon 0.51 %, available N 232.40 kg/ha, P<sub>2</sub>O<sub>5</sub> 10.60 kg/ha, and available K<sub>2</sub>O 229.50 kg/ha. The treatments comprised sixteen blackgram genotypes were laid out in randomized block design with three replications. Recommended uniform dose of N and P<sub>2</sub>O<sub>5</sub> was 20: 40 kg /ha. The entire quantity of these fertilizers was applied as basal at the time of sowing. The seeds @ 20 kg/ha were sown in lines on 9<sup>th</sup> July, 2014 at 30 cm row to row distance. The crop was harvested between 8- 26<sup>th</sup> September, 2014. All the recommended cultural practices were followed to raise the crop. The periodical observations on growth, phenological parameters, yield and yield attributes were

recorded as per treatment. The recorded data were statistically analysed. The results obtained from the experiment have been summarized as follows:

- At 15 DAS as well as at maturity stage, the differences in plant population /m<sup>2</sup> were found to be non-significant in different genotypes. It ranged from 31.27 to 32.80 plants /m<sup>2</sup> at 15 DAS and 27.20 to 29.17 plants /m<sup>2</sup> at maturity stage among all the 16 genotypes.
- The genotype TU 17 attained significantly tallest plants over all the remaining genotypes at 15 DAS and at crop maturity (12.47 to 67.94 cm). This was followed by and at par with TU 27 (12.07 cm) at 15 DAS of observation, but at par with TU 27, TU 94-2, IVU 466 and PDU 1 at maturity stage. Blackgram genotype TU 10 attained lowest plant height (8.52 and 46.42 cm) at 15 DAS and maturity stage respectively.
- At 30 DAS, IVU 466 and PDU 1 genotypes produced significantly higher number of branches (3.67 and 3.50/plant) over most of the remaining genotypes. At 60 DAS, the production trend of branches among the different genotypes was the same as observed at 30 days stage. The genotype IVU 466 recorded higher number of branches (5.23 /plant) over the remaining genotypes followed by and at par with PDU 1 (5.18 /plant), TU 57 (5.12 /plant), TU 17 (5.07 /plant), TU 27, JU 3 and TU 47-6. The lowest number of branches was produced by TU 10 genotype of blackgram at both the stage of observation.
- Out of 16 blackgram genotypes, PW 30 attained earliest days to flower initiation (29.97 days), 50 % flowering in 34.97 days and finally crop maturity in 62.47 days. The genotype which matured one day late matured in 63.68 days was TU 98-4. Contrary to this, the genotype TU 10 takes maximum 36.37 days to flower initiation, 41.38 days to 50% flowering, thereby crop maturity became late by sixteen days (78.68 days).
- Amongst the 16 genotypes of blackgram, IVU 466 brought about most of the yield attributes upto almost maximum extent i.e. 55.47 pods/plant, 3.33 cm length of pods, 4.13 grains/pod and 263.67 grains/plant. The 1000 grain weight (52.37g) was maximum in case of TU 27.

- Amongst the 16 genotypes of blackgram, IVU 466 produced the significantly higher grain yield up to 1169 kg/ha as well as straw yield up to 1559 kg/ha. The maximum (44.56 %) harvest index was recorded with JU 2. The second best genotype in respect to grain yield was PDU 1 and straw yield was in TU 17.
- Among the blackgram genotypes, IVU 466 proved highly profitable giving net income upto ₹ 32290/ha with B: C ratio upto 3.01. The other best genotypes were PDU 1, TU 57 and TU 17, which gave net income upto ₹ 31788/ha, ₹ 30677 and ₹ 30423 with B: C ratio 2.98, 2.91 and 2.90, respectively. The higher monetary gain from these three genotypes was due to their higher grain and straw yields per hectare which fetched higher market price. On the other hand, the genotypes like TU 10 recorded lowest net income ( ₹ 15475/ha) with B:C ratio 1.96 only.

## **Conclusion**

On the basis of the field experiment it was conducted that the blackgram genotype IVU 466 was found superior over rest of the varieties by obtaining higher grain yield (1169 kg/ha) and straw yield (1559 kg/ha) with highest net income ( ₹ 32290/ha) and B: C ratio (3.01) under the rainfed situation of Kymore plateau and Satpura hill zone of Madhya Pradesh. The other varieties which were able to give good yield under this type of climatic situations are PDU 1 and TU 57.

## **Suggestions**

Further research work on the same genotypes may be repeated at same location will be needed to confirm the findings of the present investigation. The experiment should be tested in different locations of the region to identify the suitability of genotypes in different areas. Then, this may be recommended to the blackgram growers of this region i.e. Kymore Plateau and Satpura hill zone of Madhya Pradesh.

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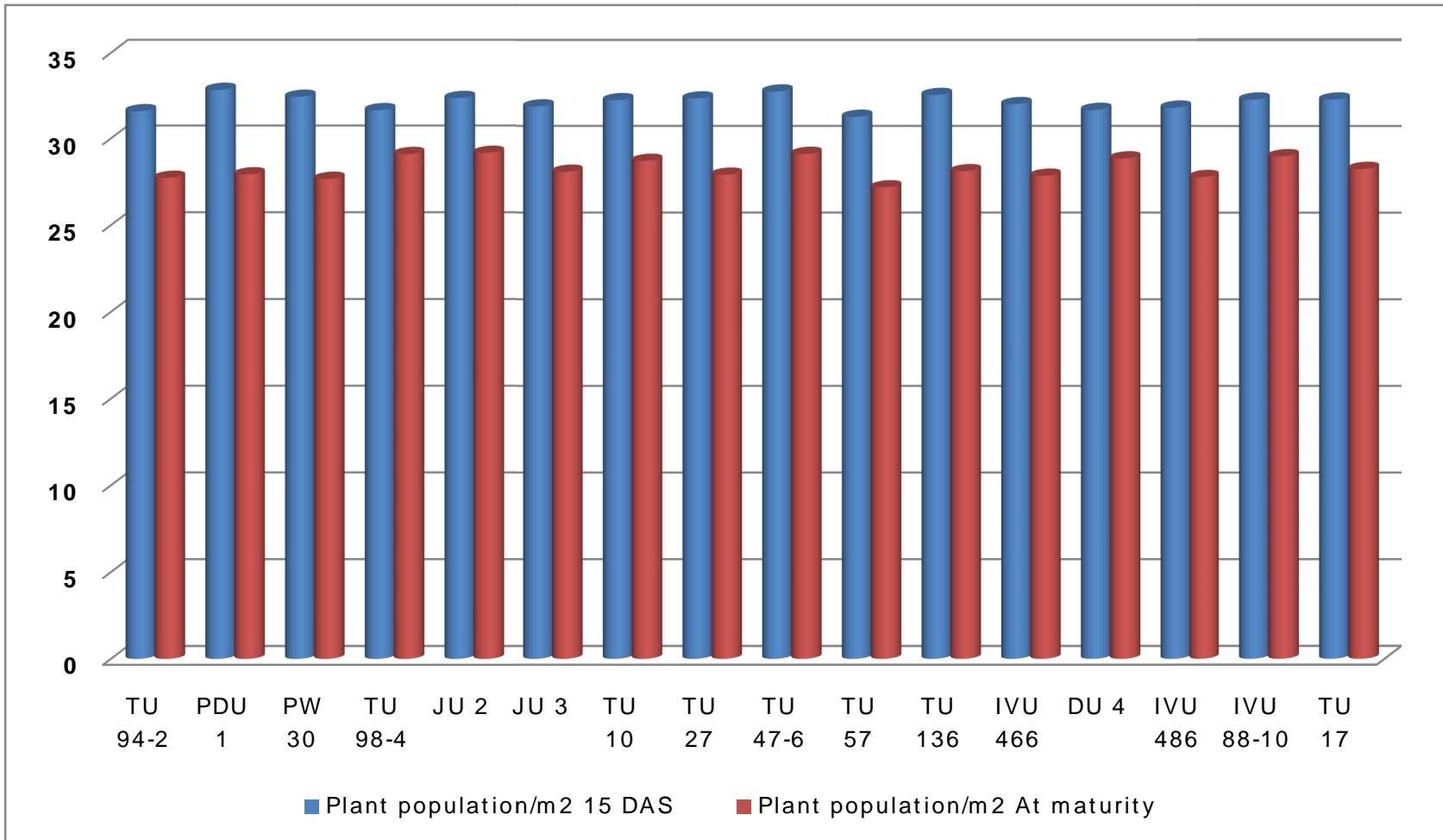
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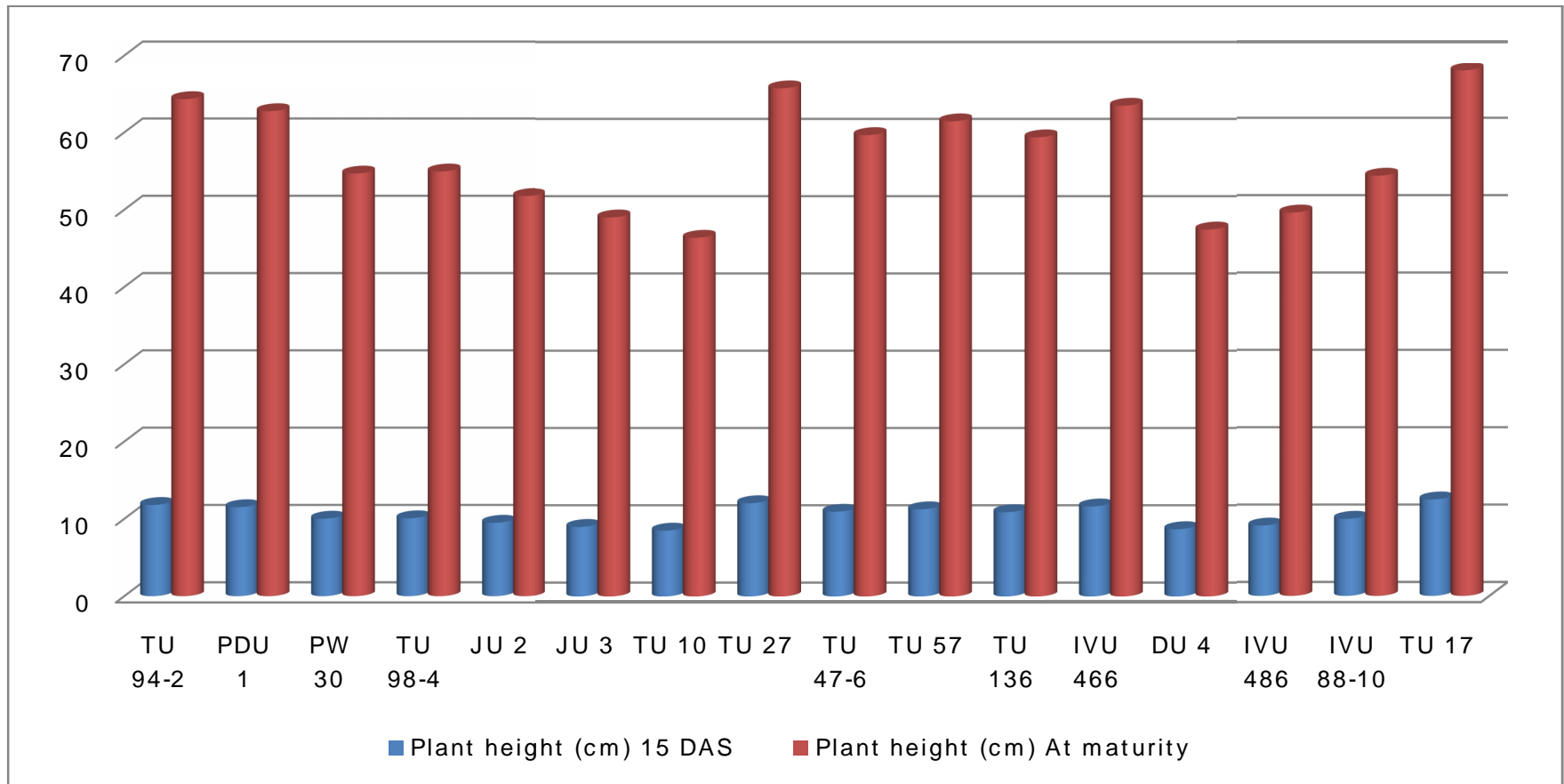
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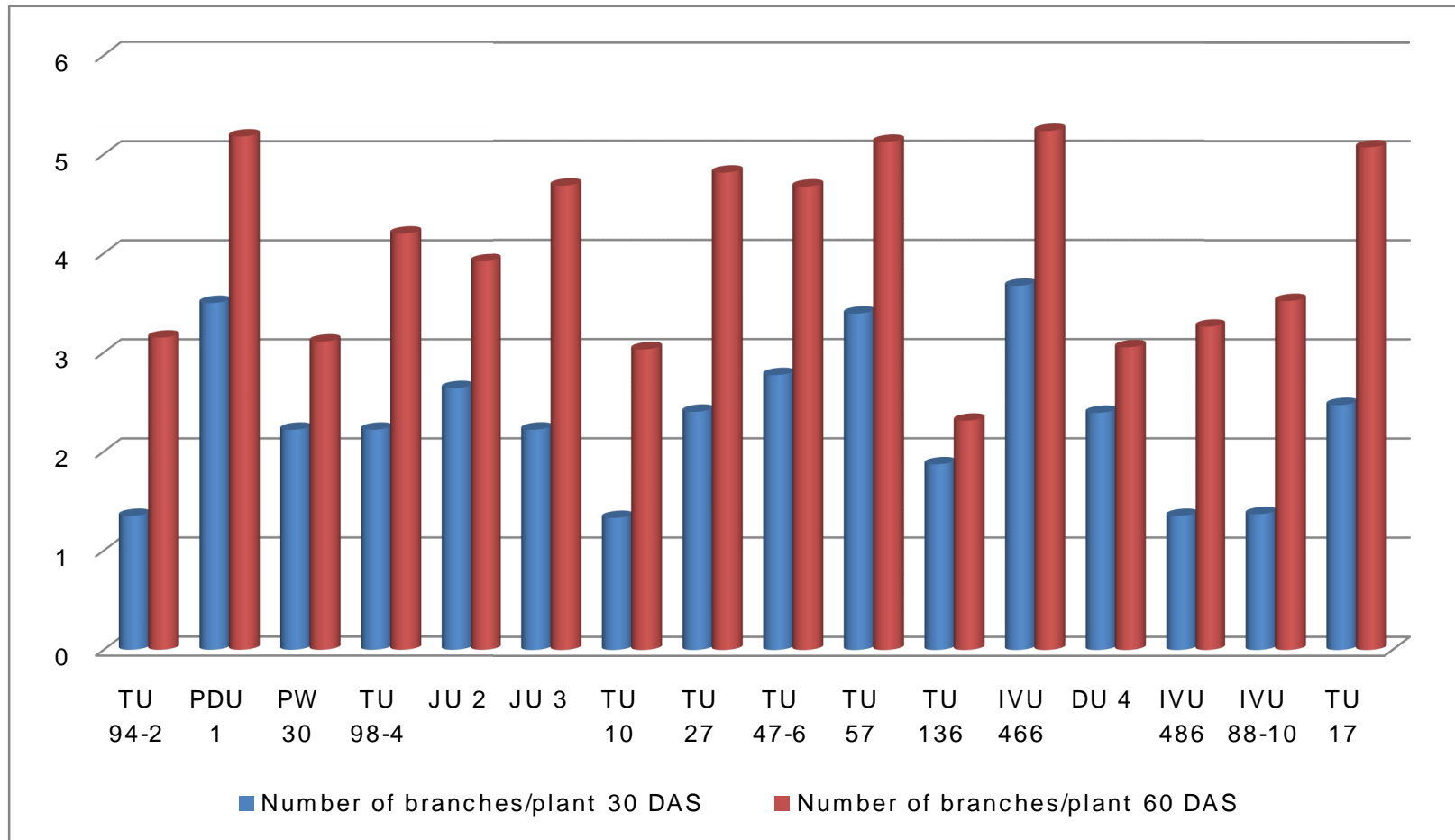
fig. 4.1 Plant population/m<sup>2</sup> of different blackgram genotypes



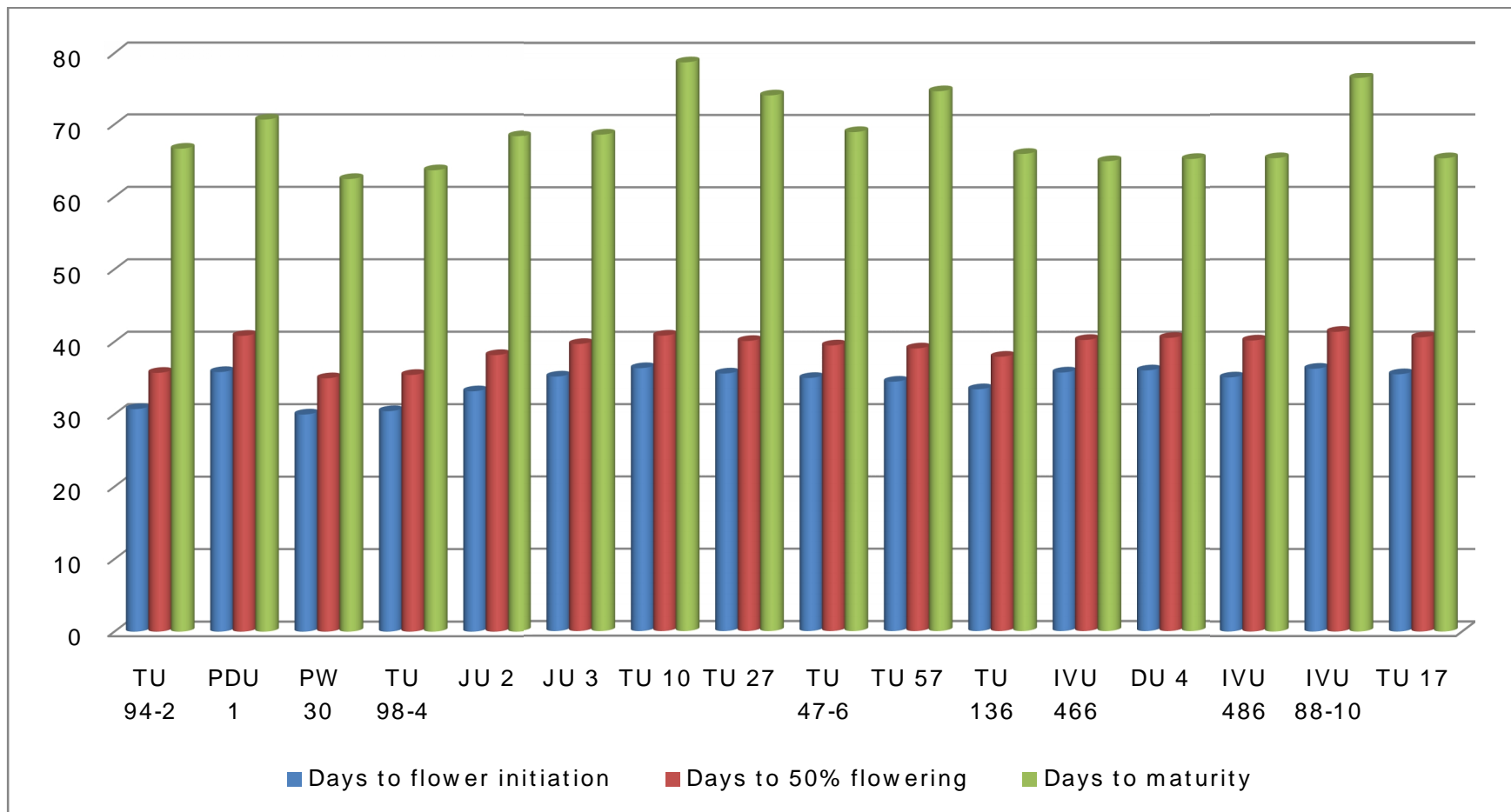
**Fig. 4.2 Plant height (cm) of different blackgram genotypes**



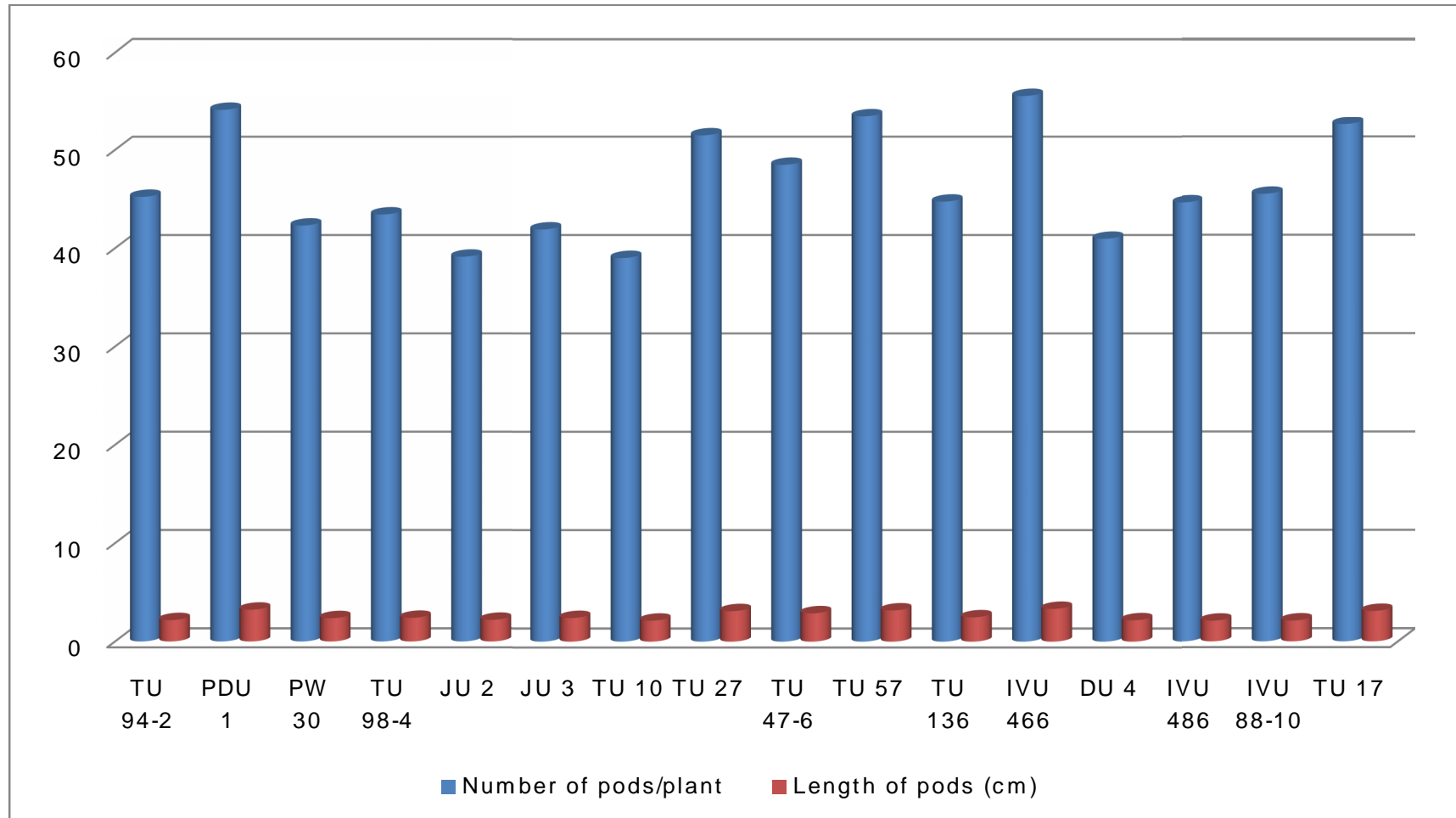
**Fig. 4.3 Number of branches per plant of different blackgram genotypes**



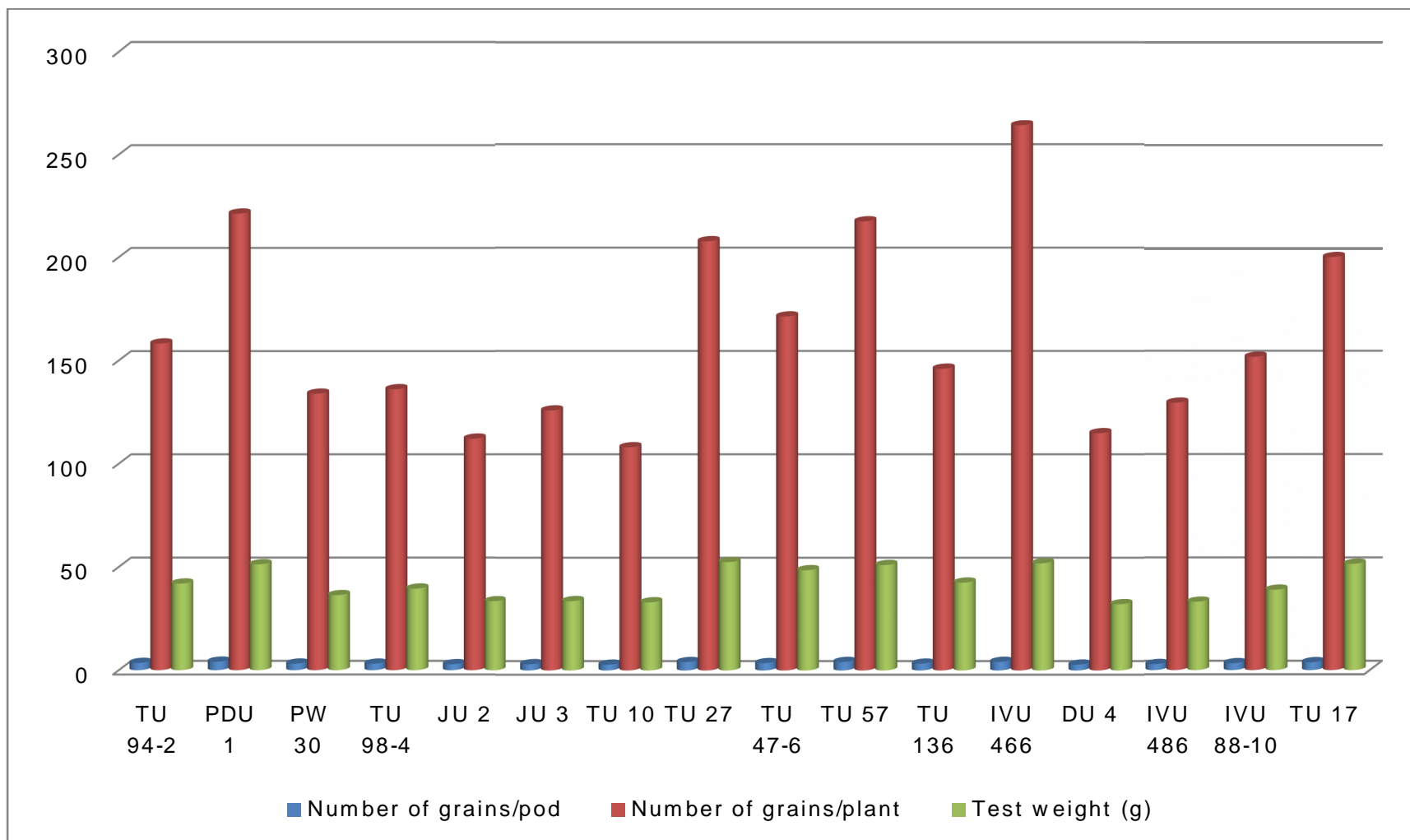
**Fig. 4.4 Days to flower initiation, Number of days to 50% flowering and maturity of different blackgram genotypes**



**Fig. 4.5 Number of pods per plant and pod length (cm) of different blackgram genotypes**



**Fig. 4.6 Number of grains per pod, grains per plant and test weight (g) of different blackgram genotypes**



**Fig. 4.7 Grain and straw yield (kg/ha) and harvest index of different blackgram genotypes**

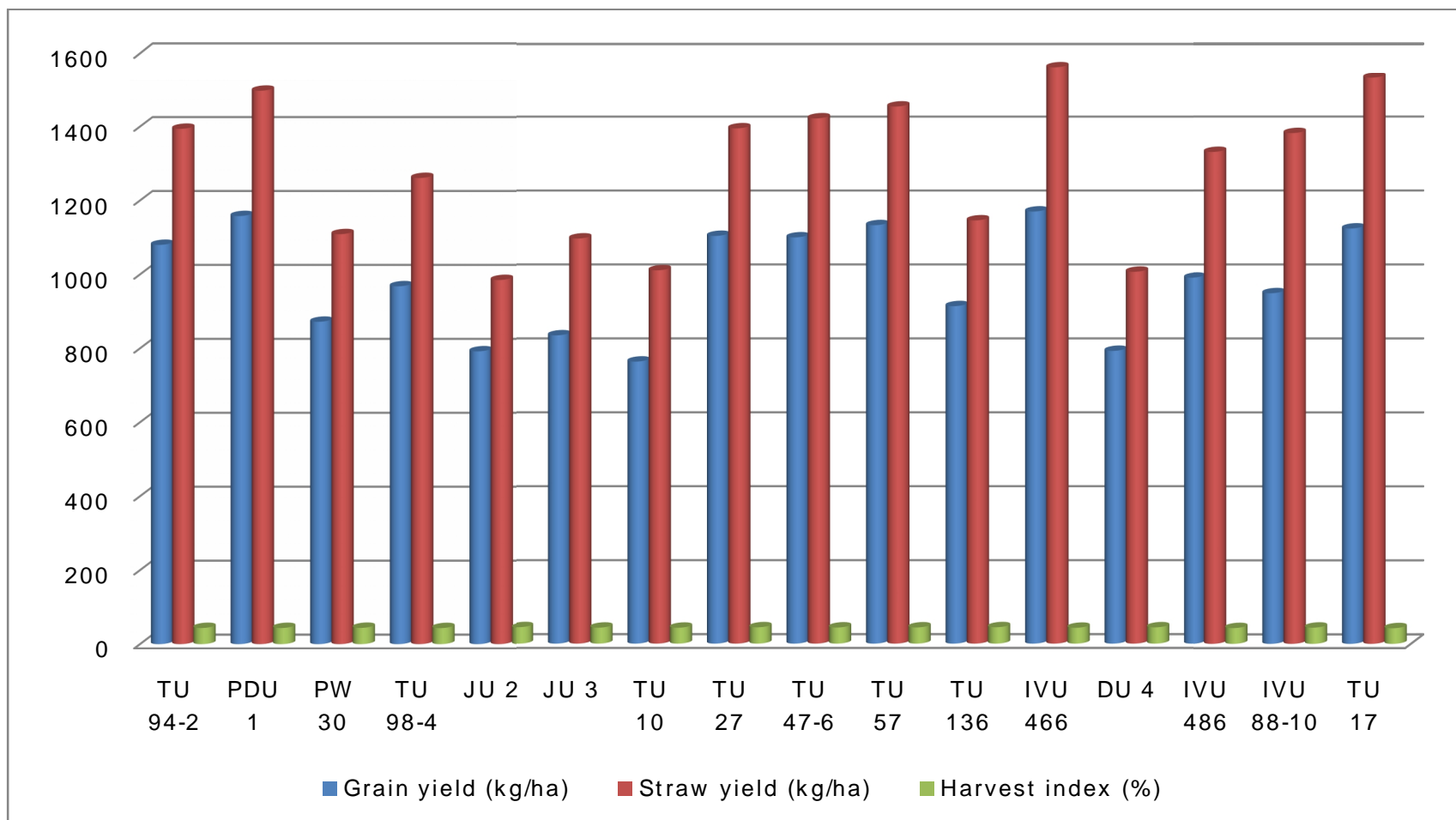
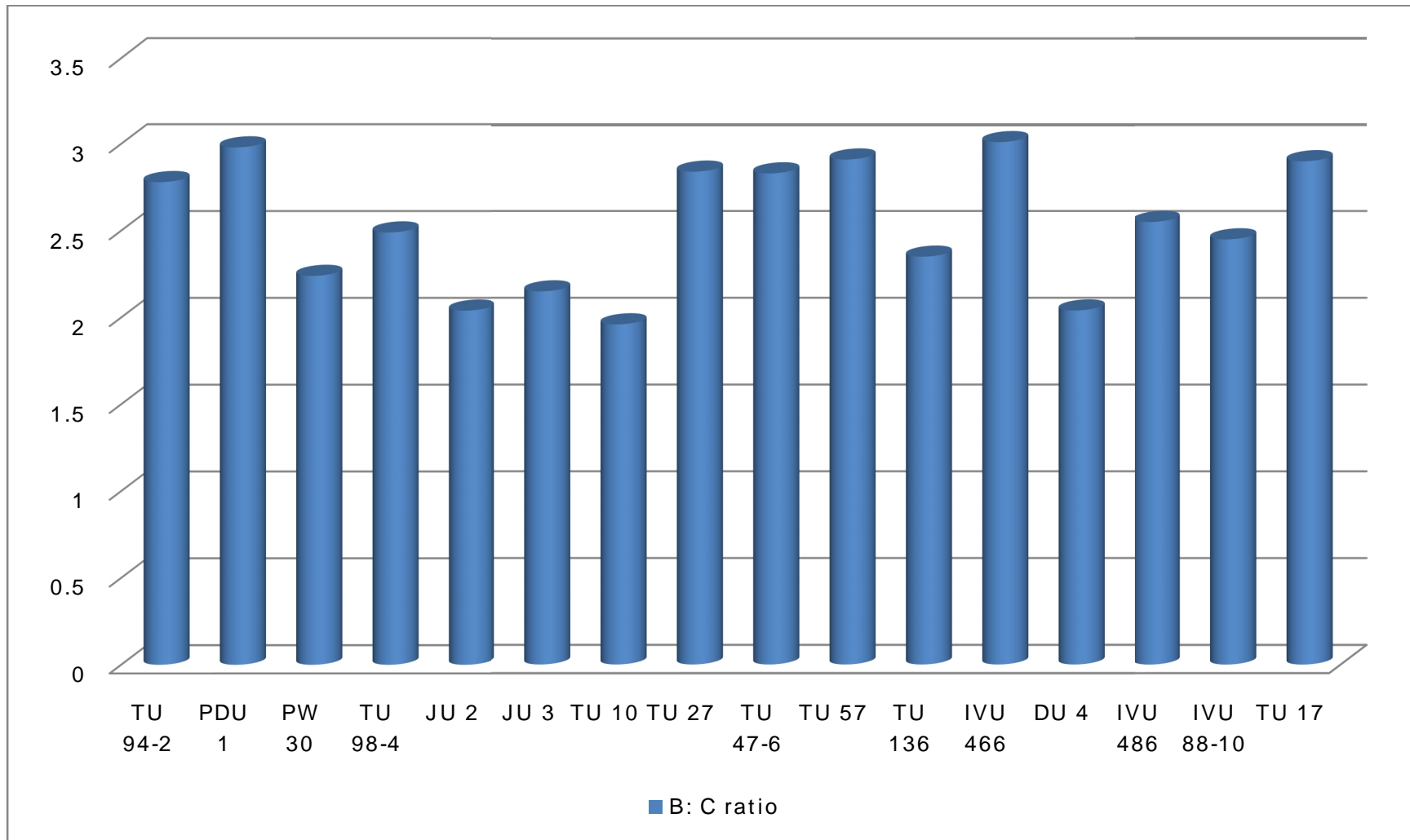
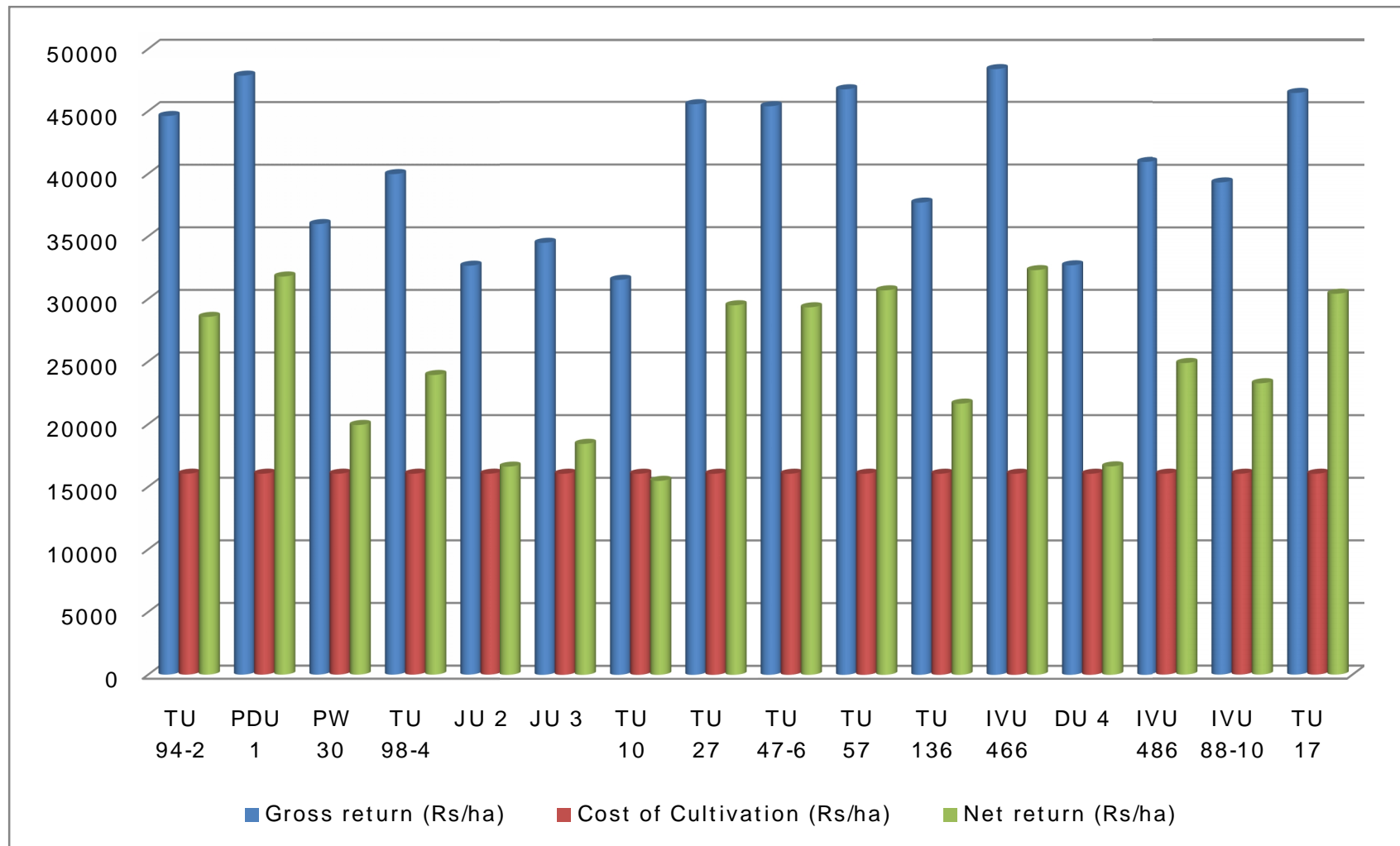


Fig. 4.9 B:C ratio of different blackgram genotypes

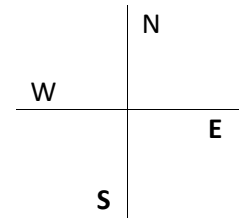


**Fig. 4.8 Gross return (₹/ha), Cost of Cultivation (₹/ha) and Net return (₹/ha) of different blackgram genotypes**









**Table 3.6 particulars of experimental layout**

R1	R2	R3
T <sub>1</sub>	T <sub>16</sub>	T <sub>12</sub>
T <sub>2</sub>	T <sub>15</sub>	T <sub>13</sub>
T <sub>3</sub>	T <sub>14</sub>	T <sub>9</sub>
T <sub>4</sub>	T <sub>13</sub>	T <sub>8</sub>
T <sub>5</sub>	T <sub>12</sub>	T <sub>7</sub>
T <sub>6</sub>	T <sub>11</sub>	T <sub>6</sub>
T <sub>7</sub>	T <sub>10</sub>	T <sub>5</sub>
T <sub>8</sub>	T <sub>9</sub>	T <sub>1</sub>
T <sub>9</sub>	T <sub>8</sub>	T <sub>2</sub>
T <sub>10</sub>	T <sub>7</sub>	T <sub>3</sub>
T <sub>11</sub>	T <sub>6</sub>	T <sub>4</sub>
T <sub>12</sub>	T <sub>5</sub>	T <sub>14</sub>
T <sub>13</sub>	T <sub>4</sub>	T <sub>15</sub>
T <sub>14</sub>	T <sub>3</sub>	T <sub>16</sub>
T <sub>15</sub>	T <sub>2</sub>	T <sub>11</sub>
T <sub>16</sub>	T <sub>1</sub>	T <sub>10</sub>

**Gross plot: 5.00mx2.10m**

**Net plot size: 4.00mx1.50m**

**Distance :30 cm**

**Replication: 3**

**Total number of plot: 48**

## APPENDICES

### Appendix I

#### Cost value and operation efficiency

S. No.	Operation	Unit cost (₹)
1	<b>Labour charge</b> <ul style="list-style-type: none"><li>• Ploughing</li><li>• Harrowing and Planking</li><li>• Man days</li></ul>	1200/ha 1200/ha @ Rs. 200/day
2	<b>Seed</b>	@ 70 /kg
3	<b>Culture</b> <ul style="list-style-type: none"><li>• Rhizobium and PSB cultures</li></ul>	@ Rs. 50 /packet
4	<b>Fertilizer</b> <ul style="list-style-type: none"><li>• DAP (18% N &amp; 46% P<sub>2</sub>O<sub>5</sub>)</li></ul>	@ Rs. 1250/q
5	<b>Sale price of produce</b> <ul style="list-style-type: none"><li>• Seed</li><li>• Straw</li></ul>	@ Rs. 4000/q @ Rs. 100/q
6	<b>Rental value of land</b>	@ Rs. 250/ha
7	<b>Interest of working capital</b>	@ Rs. 5% / Annum

## Appendix – II

### Total cost of cultivation per hectare

S. No.	Operation	Unit used	Cost per unit (Rs)	Total cost (Rs)
i.	Land preparation			
	Ploughing	1	1200	1200
	Harrowing and planking	1	1200	1200
ii.	Layout of field -Man day	3	200	600
iii.	Seed- Blackgram	20 kg	50	1000
iv.	Seed treatment with <i>Rhizobium</i> & PSB	10	25	250
v.	Sowing	15	200	3000
vi.	Thinning- Man day	3	200	600
vii	Harvesting	15	200	3000
viii	Threshing	5	200	1000
ix.	Cleaning	2	200	400
x.	Miscellaneous expdt.	-	-	1000
xi	Fertilizer- DAP	111 kg	1223	1358
xii	Placement cost for fertilizer (basal dressing)	2	200	400
xiii	Interest on working capital (5%)			784
xiv	Land revenue			250
	<b>Total</b>			<b>16042</b>

### Appendix- III

#### Plant population at 15 DAS

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	1.314	0.657	1.504	3.316
Varieties	15	8.668	0.578	1.323	2.015
Error	30	13.106	0.437		

\* Significant at 5 % level

### Appendix- IV

#### Plant population at maturity

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	4.527	2.263	0.002	3.316
Varieties	15	17.371	1.158	0.001	2.015
Error	30	38441.792	1281.393		

\* Significant at 5 % level

### Appendix- V

#### Plant height (cm) at 15 DAS

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.271	0.135	1.156	3.316
Varieties	15	73.115	4.874	41.591	2.015
Error	30	3.516	0.117		

\* Significant at 5 % level

### Appendix- VI

#### Plant height (cm) at maturity

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	8.049	4.025	0.386	3.316
Varieties	15	2171.706	144.780	13.895	2.015
Error	30	312.584	10.419		

\* Significant at 5 % level

### Appendix- VII

#### Number of branches/plant at 30 DAS

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.182	0.091	1.651	3.316
Varieties	15	26.097	1.740	31.536	2.015
Error	30	1.655	0.055		

\* Significant at 5 % level

### Appendix- VIII

#### Number of branches/plant at 60 DAS

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.176	0.088	0.437	3.316
Varieties	15	41.677	2.778	13.822	2.015
Error	30	6.030	0.201		

\* Significant at 5 % level

### Appendix- IX

#### Days to flower initiation

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.091	0.046	0.677	3.316
Varieties	15	208.918	13.928	207.160	2.015
Error	30	2.017	0.067		

\* Significant at 5 % level

### Appendix- X

#### Days to 50% flowering

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.102	0.051	0.815	3.316
Varieties	15	192.277	12.818	203.943	2.015
Error	30	1.886	0.063		

\* Significant at 5 % level

### Appendix- XI

#### Days to maturity

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.590	0.295	0.944	3.316
Varieties	15	1054.398	70.293	225.094	2.015
Error	30	9.369	0.312		

\* Significant at 5 % level

### Appendix- XII

#### Number of pods/plant

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	2.876	1.438	1.484	3.316
Varieties	15	1348.802	89.920	92.801	2.015
Error	30	29.069	0.969		

\* Significant at 5 % level

### Appendix- XIII

#### Length of pods (cm)

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.093	0.046	1.840	3.316
Varieties	15	9.644	0.643	25.481	2.015
Error	30	0.757	0.025		

\* Significant at 5 % level

### Appendix- XIV

#### Number of grains /pod

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	0.049	0.024	0.482	3.316
Varieties	15	10.993	0.733	14.485	2.015
Error	30	1.518	0.051		

\* Significant at 5 % level

### Appendix- XV

#### Number of grains/plant

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	932.859	466.429	1.206	3.316
Varieties	15	97024.723	6468.315	16.719	2.015
Error	30	11606.481	386.883		

\* Significant at 5 % level

### Appendix- XVI

#### Test weight (g)

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	5.641	2.821	2.863	3.316
Varieties	15	2866.800	191.120	193.973	2.015
Error	30	29.559	0.985		

\* Significant at 5 % level

### Appendix- XVII

#### Grain yield (kg/ha)

S.V.	d.f.	S.S.	M.S.S.	F cal.	F tab.
Replication	2	3288.292	1644.146	1.153	3.316
Varieties	15	921555.979	61437.065	43.102	2.015
Error	30	42761.708	1425.390		

\* Significant at 5 % level

**Appendix- XVIII**

**Straw yield (kg/ha)**

<b>S.V.</b>	<b>d.f.</b>	<b>S.S.</b>	<b>M.S.S.</b>	<b>F cal.</b>	<b>F tab.</b>
<b>Replication</b>	2	2660.178	1330.089	0.230	3.316
<b>Varieties</b>	15	1776394.887	118426.326	20.495	2.015
<b>Error</b>	30	173348.327	5778.278		

\* Significant at 5 % level

**Appendix- XIX**

**Harvest Index (%)**

<b>S.V.</b>	<b>d.f.</b>	<b>S.S.</b>	<b>M.S.S.</b>	<b>F cal.</b>	<b>F tab.</b>
<b>Replication</b>	2	0.021	0.011	0.896	3.316
<b>Varieties</b>	15	17.622	1.175	98.623	2.015
<b>Error</b>	30	0.357	0.012		

\* Significant at 5 % level

## ABSTRACT

1. **Title of the Thesis** : **“Performance of Black gram (*Vigna munga* L.) varieties under rainfed farming situation.”**
2. **Student** : **Vivek Verma**
3. **Permanent address** : Vidhya Nagar, Mangrul Road, Teh. and Distt. Khargone (M.P.)
4. **Advisor** : **Dr. D.P. Dubey**  
Chief Scientist & Head of Section  
Dept. of Agronomy  
College of Agriculture, Rewa
5. **Degree Awarded** : Master of Science in Agriculture  
(Agronomy)
6. **Year of award of degree** : 2014-15
7. **Major Subject** : Agronomy
8. **Total number of pages in the thesis** : 73
9. **Number of words in the abstract** : 542

**Signature**  
**( Dr. D.P. Dubey)**  
**Advisor**

**Signature**  
**(Dr. D.P. Dubey)**  
**Professor and Head**

**Signature**  
**(Vivek Verma)**  
**Student**

**“Performance of Black gram (*Vigna munga* L.) varieties under rainfed farming situation.”**

**Vivek Verma**

**Research Guide: Dr. D. P. Dubey**

**ABSTRACT**

**Part –II**

The field experiment was conducted at All India Coordinated Research Project for Dryland Agriculture, Kuthulia Farm, College of Agriculture, Rewa (M.P.) during *Kharif* 2014. The experiment was aimed to find out suitable variety for existing agro-climatic conditions of Kymore plateau and Satpura hills zone of Madhya Pradesh . The rainfall during the crop season was 814.2 mm.. The soil of the experimental field was clay loam having pH 6.72, electrical conductivity 0.14 ds/m, organic carbon 0.51 %, available N 232.40 kg/ha, P<sub>2</sub>O<sub>5</sub> 10.60 kg/ha, and available K<sub>2</sub>O 229.50 kg/ha. The treatments comprised sixteen blackgram genotypes were laid out in randomized block design with three replications. Recommended uniform dose of N and P<sub>2</sub>O<sub>5</sub> was 20: 40 kg /ha. The entire quantity of these fertilizers was applied as basal at the time of sowing. The seeds @ 20 kg/ha were sown in lines on 9<sup>th</sup> July, 2014 at 30 cm row to row distance. The crop was harvested between 8- 26<sup>th</sup> September, 2014. All the recommended cultural practices were followed to raise the crop. The treatment wise plant population, plant height, number of branches per plant, yield attributes and yield *viz.*, number of pods per plant, seeds per pod, number of seeds per plant, test weight , seed and straw yield per ha and harvest index with economics were recorded.

Amongst the 16 genotypes of blackgram, IVU 466 brought about most of the yield attributes upto almost maximum extent i.e. 55.47 pods/plant, 3.33 cm length of pods, 4.13 grains/pod and 263.67 grains/plant. The 1000 grain weight (52.37g) was maximum in case of TU 27. The blackgram genotype IVU 466 produced the significantly higher grain yield up to 1169 kg/ha as well as straw yield up to 1559 kg/ha. The maximum (44.56 %) harvest index was recorded with JU 2. The second best genotype in respect to grain yield was PDU 1 and straw yield was in TU 17.

Among the blackgram genotypes, IVU 466 proved highly profitable giving net income upto ₹ 32290/ha with B: C ratio upto 3.01. The other best genotypes were PDU 1 and TU 57, which gave net income upto ₹ 31788/ha and ₹ 30677 with B: C ratio 2.98 and 2.91, respectively. The higher monetary gain from these three genotypes was due to their higher grain and straw yields per hectare which fetched higher market price. On the other hand, the genotypes like TU 10 recorded lowest net income (₹ 15475/ha) with B:C ratio 1.96 only.