# RESPONSE OF BLACKGRAM (*Vigna mungo* L.) GENOTYPES TO DATES OF SOWING AND PHOSPHORUS LEVELS IN NORTHERN TRANSITIONAL TRACT OF KARNATAKA

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*By*

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# CERTIFICATE

This is to certify that the thesis entitled **"RESPONSE OF BLACKGRAM (*Vigna mungo* L.) GENOTYPES TO DATES OF SOWING AND PHOSPHORUS LEVELS IN NORTHERN TRANSITIONAL TRACT OF KARNATAKA"** submitted by **Mr. GURAPPA S. YADAHALLI** for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRONOMY** to the University of Agricultural Sciences, Dharwad is a record of research work done by him during the period of his study in this University under my guidance and supervision, and the thesis has not previously formed the basis for the award of any other degree, diploma, associateship, fellowship or other similar titles.

DHARWAD
September, 2002

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# CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

Contd...

# LIST OF PLATES

# APPENDICES

# Introduction

# I. INTRODUCTION

India is the largest producer and consumer of pulses in the world accounting for 29 per cent of world area and 19 per cent of world's production. At present, the total area under pulses is 25.39 million hectares, with a production of 16.10 million tonnes (Anonymous, 2000). It is estimated that the country's population will reach nearly 1350 million by 2020 A.D. The country would then need a minimum of 30.3 million tonnes of pulses to meet the requirement. Infact, there has been stagnation in the production and productivity of pulses over the past two decades. There is also diversion of acreage from pulses to cereals as a result of "green revolution" brought about by high yielding varieties of cereals (Swaminathan and Jain, 1973). This is mainly due to the low yield potential of legumes under irrigation and instability of yield. As a result, the per capita availability of pulses has declined from 64 g per capita per day (1951-56) to less than 35 g per capita per day (Asthana, 1998) as against the FAO/WHO'S recommendation of 80 g. The total pulse requirement for consumption by 2005 would figure about 23.0 million tonnes.

The important grain legumes grown in India are chickpea, pigeonpea, greengram, blackgram, cowpea, lentil, peas etc. Among these grain legumes, blackgram (*Vigna mungo* (L), Hepper), an ancient and well known leguminous crop of Asia, is popular because of its nutritional quality (Protein).

Blackgram is a highly priced pulse, rich in protein (24%) and phosphoric acid. Besides being cooked for consumption with rotis and rice, it is also used in making papads and badian. It is also used in making pastes for several south Indian dishes like idli, vada, dosa etc.

In India, blackgram is grown on 2.70 million hectares area with a production of 0.94 million tonnes. In Karnataka, it is grown on an area of 1.02 lakh hectares with a production of 0.29 lakh tonnes. However, the yield potential of this crop is very low and plagued with a number of diseases and pests.

The production of pulse crops in our country including blackgram is not enough to meet the domestic demand of the large population. There is scope to enhance the productivity of blackgram by proper agronomic practices, apart, from evolving high yielding varieties.

Recently high yielding, disease and pest resistant varieties of different growth habits have been developed. Introduction of these high yielding varieties indicated the scope of improving overall productivity of blackgram.

Production potentiality of blackgram can be fully exploited with suitable agronomic practices and genotypes. Among different practices, sowing at optimum time plays an important role to fully exploit the genetic potentiality of the variety as it provides optimum growing conditions such as temperature, light, humidity and rainfall. The growth phase of the crop should synchronize with optimum environmental conditions for better expression of growth and yield. It is fact that a specified genotype does not exhibit the same phenotypic characteristics under all environmental conditions and different genotypes respond differently to a specified environment and their relative ranking usually differed (Eberhort and Russel, 1966). This ultimately decides the selection of genotypes for particular or different dates of sowing to stabilize or to get higher yields.

Phosphorus a major element in legume nutrition, favours healthy root growth by helping in translocation of carbohydrates and promotes seed setting and seed yield. Phosphorous plays a key role in the balanced nutrition of legumes. It is also necessary for the reduction of nitrates and protein formation.

Blackgram is being grown by the farmers of transitional tract in recent years in place of traditional pulses the greengram and cowpea because of its higher price in the market. Research information on the suitability of blackgram variety, its optimum time of sowing and phosphorus requirement for higher seed yield under transition tract of Dharwad is lacking.

An effort was therefore, made to optimize the management practices to enhance blackgram productivity under vertisols of transition tract of Dharwad with the following objectives.

1) To study the performance of different blackgram genotypes,

2) To evaluate the response of blackgram genotypes to dates of sowing and phosphorus levels, and

3) To work out the economics.

# Review of Literature

# II. REVIEW OF LITERATURE

The review of literature on the effect of genotypes, dates of sowing and phosphorus levels on growth, yield and yield attributes and nutrient uptake of blackgram are presented in this chapter.

## 2.1 Performance of blackgram genotypes

Varieties play an important role in determining the yield of a crop. The potential yield of varieties within its genetic limit is set by its environment. The release of new short duration varieties of pulses is a major breakthrough in achieving increased pulse production per unit time. Yield of these varieties can be further improved by providing optimum environment by manipulating agronomic practices. Varieties differ in their yield potential depending on many physiological processes, which are controlled by both genetic makeup and the environment.

Tomar *et al.* (1984) at Jabalpur, during *Kharif* season reported that the blackgram genotype Pant U-26 resulted in significantly higher yield during both the years (1287 kg $ha^{-1}$ and 1310 kg $ha^{-1}$ in 1980 and 1981 respectively) compared to JU 78-4, JU 78-3 and T-9.

During *Kharif* season at Pantnagar, the yields of different blackgram cultivars were on par. However, T-9 recorded higher yield (8.37 q $ha^{-1}$) followed by Pant U- 19 (8.33 q $ha^{-1}$), UG 218 (8.23 q $ha^{-1}$) and UPU 9-40-4 (7.53 q $ha^{-1}$) as reported by Chaudhary *et al.* (1988).

Results of experiment conducted at Shillongani (Assam) during the post *Kharif* season of 1982 indicated that JU-78/BB121 variety gave the highest yield (1430 kg $ha^{-1}$) compared to T-9 (1202 kg $ha^{-1}$), UG-157 (1206 kg $ha^{-1}$) and was no par with that of Pant U-19 (1396 kg $ha^{-1}$) (Saharia *et al.,* 1988).

Swamy Rao and Konda (1988) at Gulbarga, reported that the blackgram genotype UPU 9 - 40 - 4 resulted in significantly higher yield (1006 kg $ha^{-1}$) compared to TAU –1 (846 kg $ha^{-1}$) and K-3 (697 kg $ha^{-1}$). Increased seed yield was attributed to significantly more number of pods $plant^{-1}$.

Tomar and Tiwari (1991) at Monera during summer season, reported that the blackgram genotype GWLS1 resulted in significantly higher yield (735 kg $ha^{-1}$) compared to PU-19 (557 kg $ha^{-1}$) and RU-2 (550 kg $ha^{-1}$) which was on par with that of JU-77-41 (605 kg $ha^{-1}$).

During rainy season at Nibuha, Mishra (1993) observed that the blackgram variety RU-2 gave significantly higher pods $plant^{-1}$, seeds $pod^{-1}$, 1000 grain weight and grain yield than that of BP-1 and local variety.

There were twelve entries in this trial, of them BRB-3 produced highest yield (13.66 q $ha^{-1}$) followed by TAU-1 (13.50 q $ha^{-1}$) and Manikya (13.3 q $ha^{-1}$) and K-3 (13.33 q $ha^{-1}$). The yield of difference amongst the entries was significant at Bheemarayanagudi. At ARS, Bidar BRB-3 produced (21.04 q $ha^{-1}$) compared to check Manikya (18.37 q $ha^{-1}$) and K-3 (20.14 q $ha^{-1}$) (Anon., 1994).

Chaudhary *et al.* (1994) at Pantnagar, reported that the blackgram cultivar T-9 recorded significantly higher plant height (cm), number of branches $plant^{-1}$ ,dry matter production at harvest and seed yield (kg $ha^{-1}$).

Jaiswal (1995) evaluated two blackgram varieties under summer condition at Jalandhar, reported that variety Mash-218 produced significantly higher seed yield (15.4 q ha$^{-1}$) than PDU-1 (12.7 q ha$^{-1}$). Increased seed yield was attributed to significantly more number of pods plant$^{-1}$, number of seeds pod$^{-1}$ and number of seeds plant$^{-1}$.

In an experiment carried out under rainfed condition at Kirei (Orissa) during *Kharif* 1992-93, it was found that blackgram genotype sarala gave higher yield (1270 kg ha$^{-1}$) compared to S-37 (1160 kg ha$^{-1}$) and was on par with that of T-9 (1225 kg ha$^{-1}$). The higher grain yield, haulm yield and harvest index (%) in case of sarala was mainly due to higher plant height (cm), number of branches plant$^{-1}$, dry matter accumulation (g) plant$^{-1}$, number of pods plant$^{-1}$, number of seeds plant$^{-1}$ and test weight (g) (Mohapatra *et al.,* 1996).

A field experiment was conducted at Vamban during *Kharif* season revealed that the genotype VB 3 registered higher yield (956 kg ha$^{-1}$ and 770 kg ha$^{-1}$ in 1993 and 1994 respectively) compared to other genotypes tested (Vairavi *et al.,* 1997).

Lal Ahmad Mohammad (1998), observed that the blackgram variety TAU-1 recorded higher growth components, yield components and seed yield (12.72 q ha$^{-1}$) compared to Manikya at Dharwad, Bidar and Bheemrayanagudi.

Singh ***et al.*** (1999), observed that the variety Pant U 35 gave significantly higher seed yield (973 kg ha$^{-1}$) over Type –9 (875 kg ha$^{-1}$) during *Kharif* season at Pantnagar. The increase in yield was due to significantly more number of pods plant$^{-1}$, number of seeds plant$^{-1}$and 100 seed weight (g).

Field trial conducted at Bapatla during *Rabi* season revealed that the seed yield of blackgram cultivars was on par. However, cultivar LBG-17 recorded higher seed yield (655 kg $ha^{-1}$) followed by LBG-20 (653 kg $ha^{-1}$), LBG-402 (653 kg $ha^{-1}$) and LBG-611 (651 kg $ha^{-1}$) (Subba Rao *et al.,* 1999).

Singh and Singh (2000), at Pantnagar found that the genotype IPU 94-1 recorded significantly higher grain yield (1020 kg $ha^{-1}$) and total uptake of nitrogen (73.1 kg $ha^{-1}$) compared to rest of the genotypes tested. The increase in yield was due to higher dry matter accumulation (g $plant^{-1}$).

Surya Kumari *et al.* (2000) reported that, among five genotypes tried LBG-623 gave significantly higher seed yield (1350 kg $ha^{-1}$) when compared to other genotypes, which could be attributed to significantly more number of pods $plant^{-1}$, number of seeds $pod^{-1}$ and 1000 grain weight (g) under irrigated conditions at Bapatla during *Kharif*, 1998-99.

At Shimoga, thirteen elite lines were evaluated in this trial. The entries differed significantly with respect to seed yield, plant height, 100 seed weight and pod length. The genotype VB-3 gave highest seed yield of 1644 kg $ha^{-1}$ followed by KU-135 (1458 kg $ha^{-1}$), AKV-7 (1417 kg $ha^{-1}$) and LBG-625 (1352 kg $ha^{-1}$) as against the check variety T-9 (1134 kg $ha^{-1}$) and K-3 (1111 kg $ha^{-1}$) Anonymous, 2001).

Ten entries evaluated in the trial differed significantly with respect to seed yield, number of pods, 100 seed weight and pod length. The entry TU-98-14 topped the list (1040 kg $ha^{-1}$) as against the check variety K-3 (1036 kg $ha^{-1}$). But their mean values are statistically at par (Anonymous, 2001).

Anonymous. (2001), observed that the tested entries were found statistically different with respect to seed yield, plant height, number of branches and 100 seed weight. The entries 2KU-171 and K-3, the check variety gave highest yield (1065 kg $ha^{-1}$) followed by 2KU-203 (984 kg $ha^{-1}$).

Patra *et al.* (2001), revealed that, blackgram varieties differed significantly with respect to seed yield. LBG-19 produced higher seed yield (1070 kg $ha^{-1}$) compared to other varieties and was on par with that of LBG-30 (1036 kg $ha^{-1}$) and sarala (980 kg $ha^{-1}$) in a study conducted at Chiplima (Orissa) during winter season.

Anonymous. (2001) revealed that the five genotypes were evaluated to know the genotype performance on their yield potentials. The genotype LBG-625 recorded significantly higher seed yield (1168.03 kg $ha^{-1}$) 100 seed weight (5.97 g) and total number of pods (36.88 $plant^{-1}$) followed by K-3 and IPU-982 with respect to yield and yield attributing characters.

## 2.2 Effect of time of sowing

Time of sowing determines the time available for vegetative growth before onset of flowering which is mainly influenced by photoperiod. Most of the blackgram genotypes are sensitive to photoperiod. Time of sowing determines the plant height, number of branches, flowering and pod bearing habits. Thus the time of sowing has prominent influence on both vegetative and reproductive processes of blackgram which has diverse effect on production of blackgram. Time of sowing has been one of the important agronomic practices and a non-cash input to enhance the yield of blackgram.

### 2.2.1 Growth attributes

Singh *et al.* (1976), reported that the blackgram sown during $30^{th}$ June took maximum days to maturity (72) compared to$15^{th}$ July (64), July $30^{th}$ (65), August $15^{th}$ (64) and August $30^{th}$ (71), at Hardoi during *Kharif* season.

Singh *et al.* (1986), at Hissar during summer, observed that among the sowing dates there is no significant difference with respect to plant height (cm) and number of plants $ha^{-1}$. However, the highest plant height (17.4 cm) and plants $ha^{-1}$ (3.7 lakhs) were recorded when crop was sown during 20$^{th}$ march.

A field experiment was carried out at Ranchi during *Kharif* season. It was found that blackgram sown during 5$^{th}$ July recorded significantly higher plant height (62.0 cm) and number of branches (4.3 $plant^{-1}$) compared to the crop sown during 20$^{th}$ July, 5$^{th}$ August, 20$^{th}$ August, 5$^{th}$ September, 20$^{th}$ September and 20$^{th}$ June (Srivastava and Verma.,1986).

In an experiment conducted at Shillongani (Assam), the results indicated that 16$^{th}$ August sown crop recorded significantly higher plant height (109.2cm) compared to the crop sown during 30$^{th}$ August (69.6 cm) and 15$^{th}$ September (Saharia, 1988).

Chaudhary *et al.* (1988) at Pantnagar during *Kharif* season, reported that blackgram sown on 6$^{th}$ July recorded higher dry matter accumulation at harvest in stem, leaves, seeds, husk compared to crop sown on 20$^{th}$ July, 5$^{th}$ August and 20$^{th}$ August.

A field experiment conducted at Modipuram (UP) during summer season, revealed that the blackgram sown during 30$^{th}$, March recorded significantly higher plant height (43.9 cm) and number of branches $plant^{-1}$ (9.5) than crop sown during 1$^{st}$ March, 10$^{th}$ March, 20$^{th}$ March and was on par with that of crop sown during 9$^{th}$ April (Gupta and Lal, 1989).

During *Kharif* season at Pantnagar, blackgram sown during 6$^{th}$ July resulted in significantly higher plant height (cm), number of trifoliate leaves plant$^{-1}$ number of branches plant$^{-1}$ and dry matter production (g plant$^{-1}$) at 30 and 60 days and at harvest compared to the crop sown during 20$^{th}$ July, 5$^{th}$ August and 20$^{th}$ August (Chaudhary et al. 1994).

Singh and Singh (2000), reported that the crop sown during 24$^{th}$ July recorded significantly higher dry matter accumulation at 30, 45, 60 and 75, days and maturity than 29$^{th}$ August sown crop at Pantnagar.

At Chiplima (Orissa) during *Rabi* season the results of a field experiment indicated that blackgram sown during 1$^{st}$ November took maximum days to 50% flowering (70) and days to maturity (102) than the 1$^{st}$ December and 1$^{st}$ January (Patra *et al*, 2001).

**2.2.2 Yield attributes and yield**

At Hardoi during *Kharif* season, the results of a field experiment indicated that blackgram (urad) sown during June, 30$^{th}$ produced significantly higher grain yield (17.6 q ha$^{-1}$) over crop sown during July 30$^{th}$ (7.9 q ha $^{-1}$), August 15$^{th}$ (7.7 q ha$^{-1}$), August 30$^{th}$ (4.6 q ha$^{-1}$) and was on par with that of crop sown during July 15$^{th}$ (16.4 q ha$^{-1}$) (Bhatnagar *et al.*, 1976)

Singh *et al.* (1976) reported that the early sowing of the crop during 20$^{th}$ March recorded higher grain yield (11.3 q ha$^{-1}$) over crop sown during 30$^{th}$ March (8.5 q ha$^{-1}$) and 10$^{th}$ April (6.8 q ha$^{-1}$). Grains pod$^{-1}$ and 1000 grain weight were not found significant. However, highest grains pod$^{-1}$ (5.4) and 1000-grain weight (37.9 g) were recorded by the crop sown during 20$^{th}$ March at Hissar during summer season.

Singh *et al.* (1986) at Hissar, observed that blackgram sowing during 5$^{th}$ July recorded significantly higher grain yield (14.2 q ha$^{-1}$) and 1000 grain weight (45.04 g) compared to crop late sown during, 20th July, 5th August, 20th August, 5th September, 20th September and 20th June.

During *Kharif* season at Pantnagar, blackgram sown during 6th July recorded significantly higher grain yield (12.00 q $ha^{-1}$) compared to 20th July (8.33 q $ha^{-1}$) 5th August (6.20 q $ha^{-1}$) and 20th August (6.00 q $ha^{-1}$) (Chaudhary *et al*, 1998).

Saharia (1988), observed that blackgram sown during 16th August recorded significantly higher grain yield (1657 kg $ha^{-1}$) compared to the crop sown during 30th August and 15th September. The higher number of pods $plant^{-1}$, seeds $pod^{-1}$ and 100 seed weight (g) were recorded when crop was sown during 16th August at Shillongani in the post *Kharif* seasons of 1982.

Gupta and Lal (1989), found that the blackgram sown during 10th March gave significantly higher grain yield (15.1 q $ha^{-1}$) than 30th March (12.4 q $ha^{-1}$) and 9th April (11.4 q $ha^{-1}$) and was on par with that of crop sown during 1st March (14.6 q $ha^{-1}$) and 20th March (14.1 q $ha^{-1}$) at Modipuram (UP) during summer season.

A field experiment conducted at Palampur during spring season of 1989 and 1990, indicated that the crop sown during 30th March recorded significantly higher grain yield (8.28 q $ha^{-1}$) compared to15th March (7.86 q $ha^{-1}$) in the year 1990. In 1988 there was no significant difference between the crop sown during 15th March and 30th March (Chakor and Rana ,1992)

Sekhon *et al*, (1993), at Ludhiana, observed that the blackgram sown on 25th, March gave higher yield than that crop sown on 1st, March.

A field experiment conducted at Pantnagar during *Kharif* season revealed that blackgram sown early on 6$^{th}$ July recorded higher grain yield and yield components compared to crop sown on late (Chaudhary *et al.*, 1994).

Jaiswal (1995) carried out a field trial in sandy loam soils during *Kharif* season. He reported that the crop sown during 25$^{th}$, March produced higher seed yield (14.5 q ha$^{-1}$), seeds pod$^{-1}$, seeds plant$^{-1}$ and number of pods plant$^{-1}$, compared to crop sown during 5$^{th}$, April and 15$^{th}$, March.

Singh *et al.* (1999) concluded that normal sowing (i.e. 3$^{rd}$ August, 24$^{th}$ July and 25$^{th}$ July during the 3 respective years) recorded higher number of pods plant$^{-1}$, number of seeds plant$^{-1}$, 100 seed weight (g) and seed yield (kg ha$^{-1}$) compared to late sowing (3 weeks after normal) at Pantnagar during *Kharif* season.

At Pantnagar during *Kharif* season, the results of a field experiment revealed that the blackgram sown during 24$^{th}$ July recorded significantly higher grain yield (1044 kg ha$^{-1}$) compared to crop sown during 29$^{th}$, August (Singh and Singh, 2000).

Blackgram sown during 1$^{st}$ January registered significantly higher seed yield (794 kg ha$^{-1}$) over crop sown during 1$^{st}$ December (730 kg ha$^{-1}$) 1$^{st}$ November (712 kg ha$^{-1}$). The higher number of pods plant$^{-1}$ (14.0), seeds plant$^{-1}$ (9.4) and 1000 seed weight (28.1 g) were also registered in early sown crop (Patra *et al.,* 2001).

Anonymous. (2001) reported that normal date of sowing (first week of July) was recorded significantly higher seed yield (951.36 kg ha$^{-1}$) than late sown on first fortnight of August (7198.98 kg ha$^{-1}$) at Shimoga.

### 2.2.3. Nutrient uptake

Chaudharuy *et al,* (1988), found that the nitrogen uptake (100.6 kg $ha^{-1}$), phosphorus uptake (14.7 kg $ha^{-1}$) and potassium uptake (70.7 kg $ha^{-1}$) were signigicantly higher in early sown blackgram during $6^{th}$ July compared to $20^{th}$ July, $5^{th}$ August and $20^{th}$ August in sandy loam soil at Pantnagar during *Kharif* season.

Singh and Singh (2000) at Pantnagar during rainy season found that the urdbean sown during $24^{th}$, July recorded significantly higher uptake of nitrogen (67.6 kg $ha^{-1}$) than the crop sown during $29^{th}$, August (60.0 kg $ha^{-1}$).

## 2.3 Effect of phosphorus levels

Phosphorus, a major element in legume nutrition, favours healthy root growth by helping in translocation of carbohydrates and promoting seed setting and seed yield. Phosphorus plays a key role in the balanced nutrition of legumes. The crop requirement should be met with phosphatic fertilizer application.

### 2.3.1 Growth attributes

Abdul Salam and Vikraman Nair (1982) at Vellanikkara, observed that the effect of phosphorus on plant height was significant in both the years. Application of 60 kg $P_2O_5$ $ha^{-1}$ was significantly superior to 30 kg $P_2O_5$ $ha^{-1}$ and the control.

Jamwal *et al.* (1989) at Varanasi during *Kharif* season on sandy clay loam soil indicated that phosphorus application significantly influenced the LAI,NAR,CGR and LAD in both the years and the application of 60 kg $P_2O_5 ha^{-1}$

[1]significantly increased their values over control. The LAD was not significant between 30 kg $P_2O_5$ $ha^{-1}$ and 60 kg $P_2O_5$ $ha^{-1}$.

Application of 30 kg $P_2O_5$ $ha^{-1}$ recorded higher drymatter accumulation at harvest during both the years compared to control and was on par with that of 60 kg $P_2O_5$ $ha^{-1}$ on sandy clay loam soil at Varansi during *Kharif* season (Jamwal *et al,* 1990).

At Mandsaur during *Kharif* season it was observed that phosphate application @ 30 kg $P_2O_5$ $ha^{-1}$ significantly increased the dry matter production of blackgram at all the growth stages and was on par with that of 60 kg $P_2O_5$ $ha^{-1}$ (Khandkar and Shinde, 1991).

At Nibuha on sandy loam soil during rainy season, application of 60 kg $P_2O_5$ $ha^{-1}$ registered higher dry weight $plant^{-1}$ compared to 20 kg $P_2O_5$ $ha^{-1}$ and control and was on par with that of 40 kg $P_2O_5$ $ha^{-1}$ (Mishra, 1993).

A field experiment conducted at Uadipur on clay loam soil during *kharif* season, indicated that the application of 30 kg $P_2O_5$ $ha^{-1}$ resulted in significantly higher plant height (cm) at both 45 DAS and harvest, primary branches $plant^{-1}$and dry matter plant $^{-1}$ (g) at harvest compared to control and was on par with that of 60 kg $P_2O_5$ $ha^{-1}$ (Singh *et al,* 1994).

Mohapatra *et al.* (1996) at Kirei (Orissa) in sandy loam soil during *Kharif* season found that the application of 40 kg $P_2O_5$ $ha^{-1}$ recorded higher plant height (48.30 cm) number of branches $plant^{-1}$ (5.8) and dry matter accumulation $plant^{-1}$ (14.7 g) compared to control and was on par with that of 80 kg $P_2O_5$ $ha^{-1}$.

At Gwalior during rainy season, application of 60 kg $P_2O_5$ $ha^{-1}$ increased the plant height significantly compared to application of 30 kg $P_2O_5$ $ha^{-1}$ and control (Trivedi, 1996).

Ramamoorthy *et al.* (1997) reported that the application of 40 kg $P_2O_5$ $ha^{-1}$ recorded higher plant height and dry matter accumulation (g $plant^{-1}$) compared to 20 kg $P_2O_5$ $ha^{-1}$ and control and was on par with that of 60 kg $P_2O_5$ $ha^{-1}$ at Pudukkottai on sandy clay loam during *Kharif* season.

Application of 60 kg $P_2O_5$ $ha^{-1}$ recorded maximum values of growth characters of blackgram like plant height and dry matter $plant^{-1}$ compared to control and 30 kg $P_2O_5$ $ha^{-1}$ and was on par with that of 90 kg $P_2O_5$ $ha^{-1}$ at Bichpuri (Agra) on sandy loam soil during rainy season (Singh and Agarwal 1999).

Narendra Singh Thakur (1999) at Chhindwara on sandy loam soil during rainy season, found that the plant height and branches $plant^{-1}$ of blackgram (CV K-3) increased with increase in each successive increment of phosphorus upto 60 kg $P_2O_5$ $ha^{-1}$ during both the consecutive years.

Srinivasan *et al.* (1999) at Vamban during *Kharif* season found that the plant height and number of branches $plant^{-1}$ in blackgram were increased with increase in phosphorus level upto 60 kg $P_2O_5$ $ha^{-1}$.

Prabhakar Reddy and Narayana Swamy (2000), reported that the application of 26.2 kg $P_2O_5$ $ha^{-1}$ significantly increased the plant height and dry matter $plant^{-1}$ compared to application of 13.1 kg $P_2O_5$ $ha^{-1}$ and control on sandy loam soil at Hyderabad during summer season.

Krishto kumar *et al.* (2001) at Ranchi during rainy season, found that the application of 40 kg $P_2O_5$ $ha^{-1}$ gave significantly higher RGR, NAR, LAR, LAI and root dry weight than the 20 kg $P_2O_5$ $ha^{-1}$ and was on par with that of 60 kg $P_2O_5$ $ha^{-1}$.

**2.3.2 Yield attributes and yield**

A field experiment conducted at Vellanikkara, indicated that the application of 60kg $P_2O_5$ $ha^{-1}$ gave the highest number of pods $plant^{-1}$, 100 seed weight, seed yield, bhusa yield and harvest index than control and was on par with that of 30 kg $P_2O_5$ $ha^{-1}$ (Abdul Salam and Vikraman Nair, 1982).

Potluri *et al.* (1986) from Hyderabad reported that each increament of phosphorus resulted in an increase in both grain and haulm yields. Application of 60 kg $P_2O_5$ $ha^{-1}$ increased the grain yield and haulm yield significantly over control and 20 kg $P_2O_5$ $ha^{-1}$ but was on par with that of 40kg $P_2O_5$ $ha^{-1}$.

Jamwal *et al.* (1989) at Varanasi on sandy clay loam soil, found that the application of 60 kg $P_2O_5$ $ha^{-1}$ resulted in higher pod number $plant^{-1}$, 1000-grain weight, grain weight $plant^{-1}$ grain yield and straw yield of blackgram over control and was on par with that of 30 kg $P_2O_5$ $ha^{-1}$.

Venkateswaralu *et al.* (1990), reported that the application of 80 kg $P_2O_5$ $ha^{-1}$ recorded significantly higher number of pods $plant^{-1}$ and grain yield over control but was statistically at par with the application of 40 kg $P_2O_5$ $ha^{-1}$ on clay loam soil at Bapatla.

A field experiment carried out on acid soil at Palampur, revealed that the application of 90 kg $P_2O_5$ $ha^{-1}$ recorded significantly higher grain yield of blackgram than the application of 40 kg $P_2O_5$ $ha^{-1}$ and control. (Shard *et al,* 1991).

At Palampur on silty clay loam soil (Alfisol) the result of a field experiment revealed that the application of 30 kg $P_2O_5$ $ha^{-1}$ gave significantly higher grain yield in both the years over control, but remained statistically at par with 60 kg $P_2O_5$ $ha^{-1}$ (Jaggi and Sharma, 1992).

Mishra (1993) observed that the application of 60 kg $P_2O_5$ $ha^{-1}$ gave significantly higher pods $plant^{-1}$, seeds $pod^{-1}$, 1000 grain weight and grain yield of blackgram than the application of 40 kg $P_2O_5$ $ha^{-1}$ 20 kg $P_2O_5$ $ha^{-1}$ and control.

Shah *et al.* (1994) from Udaipur on clay loam soil found that the application of 60 kg $P_2O_5$ $ha^{-1}$ recorded significantly higher pods $plant^{-1}$ grain weight $pod^{-1}$ pod length, test weight, grain yield, straw yield and biological yield than control but was on par with 30 kg $P_2O_5$ $ha^{-1}$.

Bhalu *et al.* (1995) reported that application of 40 kg $P_2O_5$ $ha^{-1}$ on clayey soil at Junagadh produced significantly higher seed yield and straw yield of blackgram $ha^{-1}$ compared to 20 kg $P_2O_5$ $ha^{-1}$but it was on par with that of 60 kg $P_2O_5$ $ha^{-1}$.

At Kirei (Orissa) during *Kharif* season, application of 80 kg $P_2O_5$ $ha^{-1}$ recorded significantly higher number of pods $plant^{-1}$, number of seeds $pod^{-1}$, test weight, grain yield, haulm yield and harvest index in blackgram compared to control but was on par with that of 40 kg $P_2O_5$ $ha^{-1}$ (Mohapatra *et al.,* 1996).

Trivedi (1996) reported higher pod plant$^{-1}$, seeds plant$^{-1}$, 1000 seed weight and grain yield ha$^{-1}$ with 60 kg $P_2O_5$ ha$^{-1}$ compared to control and 30 kg $P_2O_5$ ha$^{-1}$ at Shillongani.

A field experiment conducted at Pudukkottai on sandy clay loam soil during *Kharif* season, indicate that the application of 60 kg $P_2O_5$ ha$^{-1}$ resulted in higher pod length, pods plant$^{-1}$, grains pod$^{-1}$, 100 grain weight and grain yield over control and 20 kg $P_2O_5$ ha$^{-1}$ but it was on par with the application of 40 kg $P_2O_5$ ha$^{-1}$ (Ramamoorthy *et al.,* 1997).

Trivedi *et al.* (1997) found that the application of 60 kg $P_2O_5$ ha$^{-1}$ produced significantly higher seed yield, haulm yield and 1000 seed weight of blackgram than the application of 30 kg $P_2O_5$ ha$^{-1}$ and control on sandy loam soil at Gwalior.

Gunjkar *et al.* (1999), reported that the application of 75 kg $P_2O_5$ ha$^{-1}$ recorded significantly higher grain yield, number of pods plant$^{-1}$ weight of pods plant$^{-1}$, weight of grains plant$^{-1}$, pod yield and test weight, over rest of $P_2O_5$ levels and was on par with 50 kg $P_2O_5$ ha$^{-1}$on vertisol during *Kharif* season at Parabhani.

Singh and Agarwal (1999) at Bichpuri during rainy season found that the application of 60 kg $P_2O_5$ ha$^{-1}$ resulted in significantly higher number of pods plant$^{-1}$, seeds pod$^{-1}$, 1000 seeds weight and grain yield than the application of 30 kg $P_2O_5$ ha$^{-1}$ and control but it was on par with 90 kg $P_2O_5$ ha$^{-1}$.

During *kharif* season at Vamban on red lateritic soil application of 60 kg $P_2O_5$ ha$^{-1}$ resulted in significantly higher number of pods plant$^{-1}$, pod length, number of seeds $pod^{-1}$ and grain yield compared to 40 kg $P_2O_5$ $ha^{-1}$, 20 kg $P_2O_5$ $ha^{-1}$ and control (Srinivasan *et al.,* 1999).

Application of 40 kg $P_2O_5$ $ha^{-1}$ recorded significantly higher pods $plant^{-1}$, seeds $pod^{-1}$, 1000 seed weight, seed yield and straw yield $ha^{-1}$ compared to application of 20 kg $P_2O_5$ $ha^{-1}$ and control on sandy loam soil at Chhindwara (Narendra Singh Thakur, 1999).

Kishtokumar *et al.* (2000) observed significantly higher number of pods $plant^{-1}$, number of seeds $pod^{-1}$, grain weight $plant^{-1}$ and grain yield at 40 kg $P_2O_5$ $ha^{-1}$ over other P levels except 60 kg $P_2O_5$ $ha^{-1}$ with which it was on par.

At Hyderabad during summer season application of 26.2 kg $P_2O_5$ $ha^{-1}$ recorded significantly higher pods $plant^{-1}$, seeds $pod^{-1}$ seed yield and haulm yield than the application of 13.1 kg $P_2O_5$ $ha^{-1}$ and control (Prabhakar Reddy and Narayana Swamy, 2000).

Application of 45 kg $P_2O_5$ $ha^{-1}$ produced significantly highest grain yield and straw yield compared to control and was on par with the application of 25 and 35 kg $P_2O_5$ $ha^{-1}$ on sandy clay loam soil (Alfisol) at Diphu (Assam) (Singha and Sarma, 2001).

At Shimoga, sowing of blackgram var. LBG-625 and application of 100% fertilizer was found significantly superior with respect to seed yield, 100 seed weight, total pods $plant^{-1}$ and five plant yield (49.81 g) followed by 75 per cent RDF and 50 per cent RDF (Anonymous.,2001)

**2.3.3 Nutrient uptake**

The phosphorus content and total phosphorus uptake by blackgram was increased due to fertilization from 0 to 60 kg $P_2O_5$ $ha^{-1}$ in black soil at

Hyderabad. However, the rate of increase was more upto 40 kg $P_2O_5$ $ha^{-1}$ (Potluri *et al.,* 1986).

Uptake of nitrogen, phosphorus, potassium, calcium and magnesium by the blackgram was significantly higher, with the increasing level of phosphorus application from 0 to 60 kg $P_2O_5$ $ha^{-1}$ on sandy clay soil at Varanasi (Jamwal *et al.,* 1990).

Phosphorus and sulphur uptake by blackgram increased significantly upto 30 kg $P_2O_5$ $ha^{-1}$ beyond which it remained statistically at par on alfisol at Palampur (Jaggi and Sharma, 1992).

Uptake of nitrogen, phosphorus and potassium was higher due to phosphorus fertilization from 0 to 60 kg $P_2O_5$ $ha^{-1}$ (Shah *et al.,* 1994).

The nitrogen and phosphorus uptake by seeds and straw of blackgram at 40 and 60 kg $P_2O_5$ $ha^{-1}$ were statistically on par, but significantly higher than that of 20 kg $P_2O_5$ $ha^{-1}$ (Bhalu *et al.,* 1995).

Trivedi (1996) reported that the nitrogen and phosphorus nutrient content in blackgram seed was increased with the increasing rates of phosphorus application in sandy clay loam soil at Gwalior during rainy season.

Trivedi *et al.* (1997) observed that the total nutrient uptake of nitrogen, phosphorus and sulphur by crop increased significantly with increasing rate of phosphorus fertilization in sandy loam soil at Gwalior during *Rabi* season.

Nitrogen, phosphorus and potassium content was higher due to phosphorus fertilization from 0 to 90 kg $P_2O_5$ $ha^{-1}$. However, the rate of increase was more upto 60 kg $P_2O_5$ $ha^{-1}$ (Singh and Agarwal, 1999).

Prabhakar Reddy and Narayana Swamy (2000) reported higher P-content in seed and haulm with increased phosphorus fertilization from 0 to 26.2 kg $P_2O_5$ $ha^{-1}$.

Singha and Sarma (2001) at Diphu on sandy clay loam soil observed that the nitrogen, phosphorus and potassium uptake by blackgram increased with increasing levels of P application. However, application of 35 and 45 kg $P_2O_5$ $ha^{-1}$ were on par with respect to N and P uptake by the crop.

## 2.4 Interaction effect of genotype, time of sowing and phosphorus levels

### 2.4.1 Growth attributes

Plant height, dry matter accumulation, number of branches $plant^{-1}$, leaf area $plant^{-1}$ and leaf area index did not differ significantly due to interaction effect of soybean varieties and phosphorus levels. (Jayanathkumar,1993).

### 2.4.2 Yield attributes

Tomar *et al.* (1984) at Jabalpur on vertisol found that the interaction effect between varieties and NP fertility levels were not significant. However, the maximum production of urdbean was secured by growing pant –U-26 with a fertility level of $N_{20}P_{50}$ kg $ha^{-1}$.

Patel *et al.* (1986) reported that the groundnut variety M13 sown with the onset of monsoon recorded significantly higher pod yields during 1983-84, 1984-85 and on pooled basis, but it was not significant during 1982-83. The yield decreased with the delay in sowing.

A field experiment carried out at Shillongani during *Rabi* season, indicated that the interaction effects between sowing dates and varieties were significant. Early sowing dates and varieties were significant. Early sowing of pea variety KPSD1 on 10th November gave significantly higher yield compared to late sowing (Saharia, 1986).

Vyas *et al.* (1987) obtained higher soybean seed yield of 1840 kg $ha^{-1}$ with JS-72-44 compared to MACS-13 (1590 kg $ha^{-1}$) by the application of 66 kg $P_2O_5$ $ha^{-1}$.

Paikera *et al.* (1988) reported that the variety T-49, JS-72-44 and PK-73-163 supplied with 40 kg N and 60 kg $P_2O_5$ $ha^{-1}$ gave soybean seed yield of 672, 517 and 455 kg $ha^{-1}$, respectively, compared to no fertilizer (239,169 and 156 kg $ha^{-1}$, respectively).

Saharia (1988) reported that the interactions between sowing dates and varieties were not significant during 1981 but it was significant in 1982. It was observed that all the varieties except T-9 gave higher grain yield in early sowing (16th August) compared to late sowing (15th September).

Jayapaul and Ganesaraja (1990) obtained higher seed yield of 3943 kg $ha^{-1}$ with the soybean variety UGM-33 compared to Co-1 (3664 kg $ha^{-1}$) with the application of 80 kg $P_2O_5$ $ha^{-1}$.

Kumpawat *et al.* (1990) at Arjia, observed that the varieties and phosphorus interactions were not significant during all the three years in chickpea.

Jayanthkumar (1993) revealed that the soybean varieties and phosphorus levels were not found significant with respect to number of pods $plant^{-1}$, pod weight $plant^{-1}$, pod length, seed weight $pod^{-1}$, days taken for maturity, 100-seed weight, seed yield, haulm yield and biological yield.

### 2.4.3 Nutrient uptake

The nitrogen, phosphorus and potassium uptake did not differ significantly due to interaction effect of varieties and phosphorus levels. (Jayanthkumar, 1993).

## 2.5 Economics

Net return (Rs. 1,650 $ha^{-1}$) and ICBR (1:3.17) were higher with the application of 30 kg $P_2O_5$ $ha^{-1}$ than 60 kg $P_2O_5$ $ha^{-1}$in blackgram (Bhalu *et al.,* 1995).

At Palampur under rainy season of 1988 and 1989 the highest benefit cost ratio (15.6) was obtained in blackgram by the application of 30 kg $P_2O_5$ $ha^{-1}$ than 60 kg $P_2O_5$ $ha^{-1}$ (Jaggi and Sharma, 1992).

Trivedi (1996) found that the application of 60 kg $P_2O_5$ $ha^{-1}$ realised higher net returns (Rs. 3093 $ha^{-1}$) from black gram at Gwalior.

Trivedi *et al.* (1997) found that the application of 60 kg $P_2O_5$ $ha^{-1}$ increased the gross returns (Rs. 4976 $ha^{-1}$). net returns (Rs. 1579 $ha^{-1}$) and BC ratio (1.46) of blackgram.

Srinivasan *et al.* (1999) realized the highest net profit (Rs. 7210 $ha^{-1}$) and cost benefit ratio (2.17) with 60 kg $P_2O_5$ $ha^{-1}$ in blackgram.

Prabhakar Reddy and Narayan Swamy (2000) obtained the higher additional net returns (Rs. 2953 $ha^{-1}$) and ICBR (1:2.66) in blackgram by the application of 26.2 kg $P_2O_5$ $ha^{-1}$.

# Material and Methods

# III. MATERIAL AND METHODS

A field experiment entitled "Studies on response of blackgram genotypes to dates of sowing and phosphorus levels was conducted during *Kharif* 2001, at the Main Research Station, University of Agricultural Sciences, Dharwad (Karnataka) under rainfed condition. The details of the material used and the experimental techniques adopted during the course of investigation are presented in this chapter.

## 3.1 Experimental Site

The experiment was conducted at the Main Research Station, University of Agricultural Sciences, Dharwad, which is located at a latitude of 15° 26′ N and longitude of $70^0$ 7′ E with an altitude of 678 m above mean sea level. The experimental site was located in E block.

## 3.2 Soil and its characteristics

The soil of the experimental site belongs to vertisols. A composite soil sample was collected from 0 to 30 cm depth in experimental plot before sowing and analyzed for physical and chemical properties. The results of the soil analysis along with methods followed are furnished in Table 1.

## 3.3 Climate Conditions

The Main Research Station is situated in Northern transitional zone (Zone-8) of the state. This zone receives the rainfall from both Southwest and Northeast monsoons, which is well distributed from June to November with lower co-efficient of variation. The mean monthly meteorological data on

Table 1. Physical and chemical properties of the soil of experimental area

| Sl. No. | Particulars | Value obtained | Rating | Method adopted |
|---|---|---|---|---|
| **I.** | **Physical properties** | | | |
| **1.** | **Mechanical analysis** | | | |
| | Coarse sand | 6.28% | Clay | International Pipette Method (Piper, 1966) |
| | Fine sand | 14.27% | | |
| | Silt | 27.52% | | |
| | Clay | 51.99% | | |
| **2.** | **Bulk density (Mg $m^{-3}$)** | 1.33 | | Core Sampler Method (Dastane, 1967) |
| **II.** | **Chemical properties** | | | |
| 1. | Soil pH (1:2.5 soil water extract) | 7.6 | Slightly alkaline | pH meter (Piper, 1966) |
| 2. | Electrical conductivity ($dSm^{-1}$) | 0.28 | Normal | Conductivity Bridge (Jackson, 1973) |
| 3. | Organic carbon (%) | 0.52 | Medium | Wet oxidation method (Jackson, 1973) |
| 4. | Available nitrogen (N) (Kg $ha^{-1}$) | 221 | Low | Alkaline permanganate method (Subbaiah and Asija, 1959) |
| 5. | Available phosphorus ($P_2O_5$) (kg $ha^{-1}$) | 32.4 | Medium | Olsen's Method (Jackson, 1973) |
| 6. | Available potassium ($K_2O$) (kg $ha^{-1}$) | 318.7 | High | $NH_4OAC$ Extract method (Jackson, 1973) |

rainfall, temperature and relative humidity during the period of experimentation (2001) and an average data for the past 51 years (1950-2000) are presented in Table 2 and depicted in Fig. 1. During the year 2001, the total rainfall of 269.6 mm was received which were 515.13 mm less than the average for the past 51 years. During the period of experimentation (June to October) a rainfall of 194.3 mm was received. The mean monthly maximum temperature ranged from 26.8° C (July) to 30.3°C (June) while, the mean monthly minimum temperature ranged from 19.9° c (October) to 21.3°C (June). The mean relative humidity was highest during the months of July and August (81%) and was lowest in October (66%). The weekly weather data during cropping period has been furnished in Appendix I.

### 3.4 Previous cropping history

The crop of fodder maize was raised during *Kharif* and chickpea was taken during *Rabi* in the year 2000.

### 3.5 Experimental details

The details of the experiment with regard to treatments, design of layout and plot size etc. is given below.

#### 3.5.1 Treatments

There were 18 treatment combinations consisting of three genotypes of blackgram, three dates of sowing and two phosphorus levels.

**Table 2. Monthly meteorological data for the year 2001 and average of past 51 years (1950-2001) of Main Research Station, University of Agricultural Sciences, Dharwad**

| Month | Rainfall (mm) | | Relative humidity (%) | | Temperature (°C) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 2001 | | 1950-2000 | |
| | 2001 | 1950-2000 | 2001 | 1950-2000 | Maximum | Minimum | Maximum | Minimum |
| January | 0.00 | 0.10 | 55.00 | 63.90 | 29.90 | 15.00 | 29.21 | 14.11 |
| February | 0.00 | 0.00 | 50.00 | 51.25 | 34.00 | 16.80 | 34.61 | 15.95 |
| March | 0.00 | 7.37 | 45.00 | 56.92 | 35.30 | 18.50 | 35.76 | 18.78 |
| April | 52.10 | 47.90 | 55.00 | 78.28 | 35.70 | 22.00 | 37.10 | 21.32 |
| May | 23.10 | 84.61 | 59.00 | 67.16 | 34.80 | 21.50 | 36.59 | 21.45 |
| June | 32.50 | 113.10 | 75.00 | 82.00 | 30.30 | 21.30 | 29.48 | 21.20 |
| July | 33.10 | 153.11 | 81.00 | 87.88 | 26.80 | 21.10 | 27.04 | 20.95 |
| August | 58.10 | 98.67 | 81.00 | 86.83 | 27.20 | 20.90 | 27.02 | 20.63 |
| September | 53.60 | 104.97 | 72.00 | 82.86 | 30.10 | 20.20 | 28.74 | 20.17 |
| October | 17.00 | 135.39 | 65.00 | 77.04 | 30.10 | 19.90 | 30.10 | 19.27 |
| November | 0.00 | 33.75 | 55.00 | 68.68 | 31.00 | 17.90 | 29.39 | 15.41 |
| December | 0.00 | 5.76 | 55.00 | 64.58 | 29.60 | 13.70 | 29.15 | 13.41 |
| Total | 269.60 | 784.73 | - | - | - | - | - | - |

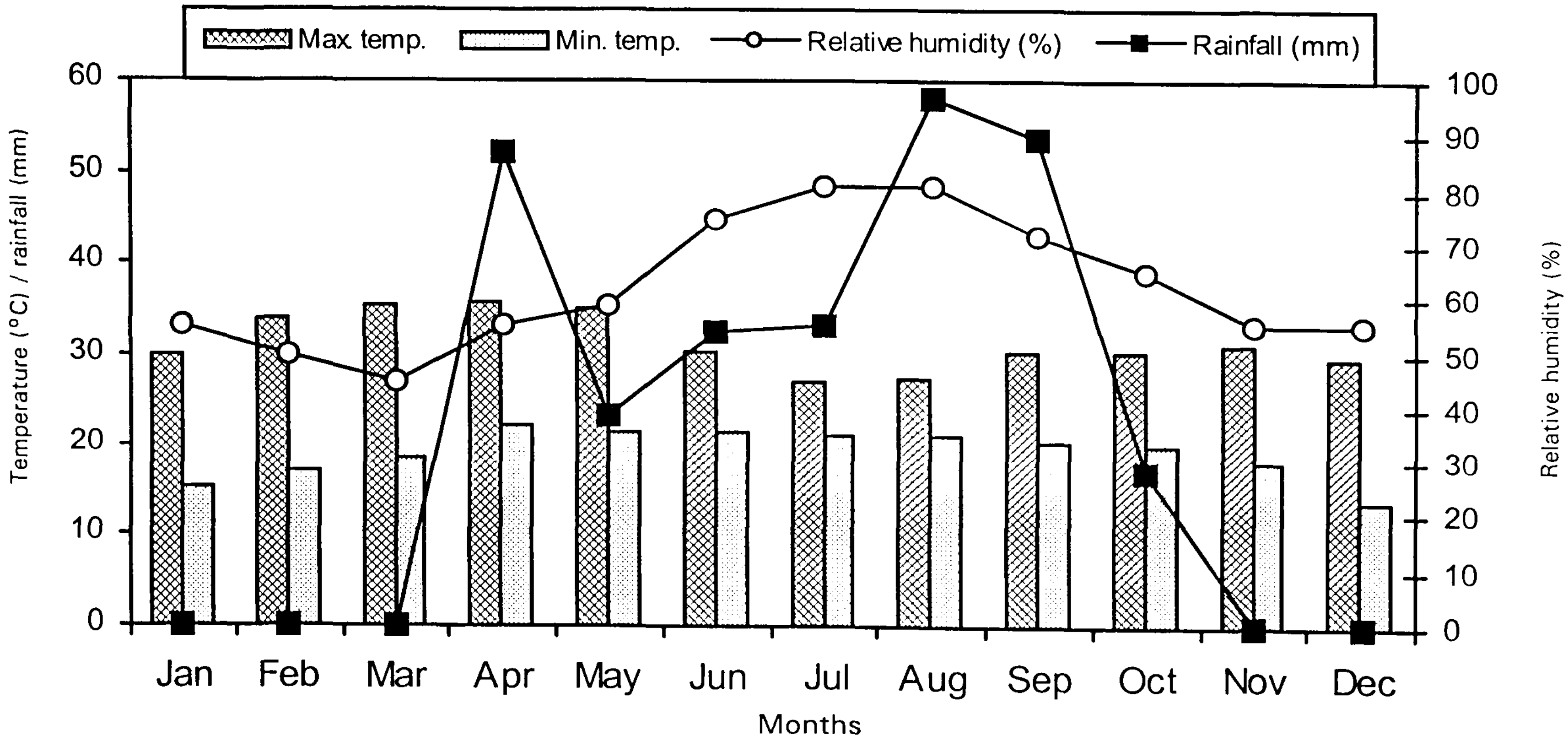


**Fig. 1. Monthly meteorological data for the year 2001 and average of 51 years (1950-2000) as recorded at the Meteorological Observatory, MRS, UAS, Dharwad**

### 3.5.2 Treatment details

**Factor I. Genotypes (G)**

1) TAU-1 ($G_1$)

2) Manikya ($G_2$)

3) K-3 ($G_3$)

**Factor II. Dates of sowing (D)**

1) 16th June ($D_1$)

2) 1st July ($D_2$)

3) 16th July ($D_3$)

**Factor III. Phosphorus levels (P)**

1) 50 kg $P_2O_5$ $ha^{-1}$ ($P_1$)

2) 75 kg $P_2O_5$ $ha^{-1}$ ($P_2$)

### 3.5.3 Treatment combinations

| | | | | | |
|---|---|---|---|---|---|
| 1) | $G_1P_1D_1$ | 7) | $G_2P_1D_1$ | 13) | $G_3P_1D_1$ |
| 2) | $G_1P_1D_2$ | 8) | $G_2P_1D_2$ | 14) | $G_3P_1D_2$ |
| 3) | $G_1P_1D_3$ | 9) | $G_2P_1D_3$ | 15) | $G_3P_1D_3$ |
| 4) | $G_1P_2D_1$ | 10) | $G_2P_2D_1$ | 16) | $G_3P_2D_1$ |
| 5) | $G_1P_2D_2$ | 11) | $G_2P_2D_2$ | 17) | $G_3P_2D_2$ |
| 6) | $G_1P_2D_3$ | 12) | $G_2P_2D_3$ | 18) | $G_3P_2D_3$ |

### 3.5.4 Details of treatment combinations

| | |
|---|---|
| $T_1$ | TAU-1 sown on 16th June with 50 kg $P_2O_5$/ha |
| $T_2$ | TAU-1 sown on 1st July with 50 kg $P_2O_5$/ha |
| $T_3$ | TAU-1 sown on 16th July with 50 kg $P_2O_5$/ha |
| $T_4$ | TAU-1 sown on 16th June with 75 kg $P_2O_5$/ha |
| $T_5$ | TAU-1 sown on 1st July with 75 kg $P_2O_5$/ha |
| $T_6$ | TAU-1 sown on 16th July with 75 kg $P_2O_5$/ha |
| $T_7$ | Manikya sown on 16th June with 50 kg $P_2O_5$/ha |
| $T_8$ | Manikya sown on 1st July with 50 kg $P_2O_5$/ha |
| $T_9$ | Manikya sown on 16th July with 50 kg $P_2O_5$/ha |
| $T_{10}$ | Manikya sown on 16th June with 75 kg $P_2O_5$/ha |
| $T_{11}$ | Manikya sown on 1st July with 75 kg $P_2O_5$/ha |
| $T_{12}$ | Manikya sown on 16th July with 75 kg $P_2O_5$/ha |
| $T_{13}$ | K-3 sown on 16th June with 50 kg $P_2O_5$/ha |
| $T_{14}$ | K-3 sown on 1st July with 50 kg $P_2O_5$/ha |
| $T_{15}$ | K-3 sown on 16th July with 50 kg $P_2O_5$/ha |
| $T_{16}$ | K-3 sown on 16th June with 75 kg $P_2O_5$/ha |
| $T_{17}$ | K-3 sown on 1st July with 75 kg $P_2O_5$/ha |
| $T_{18}$ | K-3 sown on 16th July with 75 kg $P_2O_5$/ha |

### 3.5.5 Design and layout

The experiment was laid out in randomized complete block design (factorial concept) with three replications as depicted in Fig. 2 and Plate 1.

### 3.5.6 Plot size

| | | |
|---|---|---|
| Gross plot | : | 4.5 m x 3.0 m |
| Net plot | : | 3.3 m x 2.6 m |
| Spacing | : | 30 cm x 10 cm |

## 3.6 Cultural Operations

### 3.6.1 Land Preparation

The land was ploughed once with mould board plough and harrowed twice to bring the soil to fine tilth. Stubbles and weeds were removed from the experimental area and the land was smoothened with a wooden plank to prepare fine seedbed.

### 3.6.2 Application of fertilizers

A common dose of nitrogen for blackgram (25 kg $ha^{-1}$) in the form of urea was applied for all the treatments. Phosphorus was applied as per treatment in the form of super phosphate. The entire quantity of fertilizer was applied as basal at the time of sowing. No potassium fertilizer was applied.

### 3.6.3 Seeds and sowing

Shallow furrows were opened at 30 cm apart, with the help of a marker. Healthy seeds of blackgram genotypes (TAU-1, Manikya and K-3)

Plate 1. General view of the experiment

were selected and treated with Rhizobium at the rate of 375 g $ha^{-1}$ and sowing was done as per treatments.

The details of sowing dates are given below.

16th June, 2001

1st July 2001

16th July 2001

### 3.6.4 After Care

Thinning was done 15 days after sowing, maintaining one healthy plant at a distance of 10 cm within the row. Hand weeding was carried out twice at 25 and 50 DAS. Monocrotophos @ 25 ml per 18 litres of water was sprayed twice for controlling the pests, during flowering and pod development stages.

### 3.6.5 Harvesting and threshing

Crop was harvested at different dates depending on maturity (Appendix -II). The plants were uprooted from the net plot and sun dried in threshing yard. Later, the plants were threshed. The seeds were cleaned and dried to a moisture content of 13 per cent and net plot yield was recorded in different treatments.

### 3.6.6 Genotype characteristics

The genotypes namely TAU-1, Manikya and K-3 were used. Plant samples are shown in Plate 2, 3 and 4.

Plate 2. Blackgram genotype TAU-1

Plate 3. Blackgram genotype Manikya

Plate 4. Blackgram genotype K-3

## Legend

$T_1$ - TAU-1 sown on 16th June with 50 kg $P_2O_5$/ha

$T_2$ - TAU-1 sown on 1st July with 50 kg $P_2O_5$/ha

$T_3$ - TAU-1 sown on 16th July with 50 kg $P_2O_5$/ha

$T_4$ - TAU-1 sown on 16th June with 75 kg $P_2O_5$/ha

$T_5$ - TAU-1 sown on 1st July with 75 kg $P_2O_5$/ha

$T_6$ - TAU-1 sown on 16th July with 75 kg $P_2O_5$/ha

$T_7$ - Manikya sown on 16th June with 50 kg $P_2O_5$/ha

$T_8$ - Manikya sown on 1st July with 50 kg $P_2O_5$/ha

$T_9$ - Manikya sown on 16th July with 50 kg $P_2O_5$/ha

$T_{10}$ - Manikya sown on 16th June with 75 kg $P_2O_5$/ha

$T_{11}$ - Manikya sown on 1st July with 75 kg $P_2O_5$/ha

$T_{12}$ - Manikya sown on 16th July with 75 kg $P_2O_5$/ha

$T_{13}$ - K-3 sown on 16th June with 50 kg $P_2O_5$/ha

$T_{14}$ - K-3 sown on 1st July with 50 kg $P_2O_5$/ha

$T_{15}$ - K-3 sown on 16th July with 50 kg $P_2O_5$/ha

$T_{16}$ - K-3 sown on 16th June with 75 kg $P_2O_5$/ha

$T_{17}$ - K-3 sown on 1st July with 75 kg $P_2O_5$/ha

$T_{18}$ - K-3 sown on 16th July with 75 kg $P_2O_5$/ha

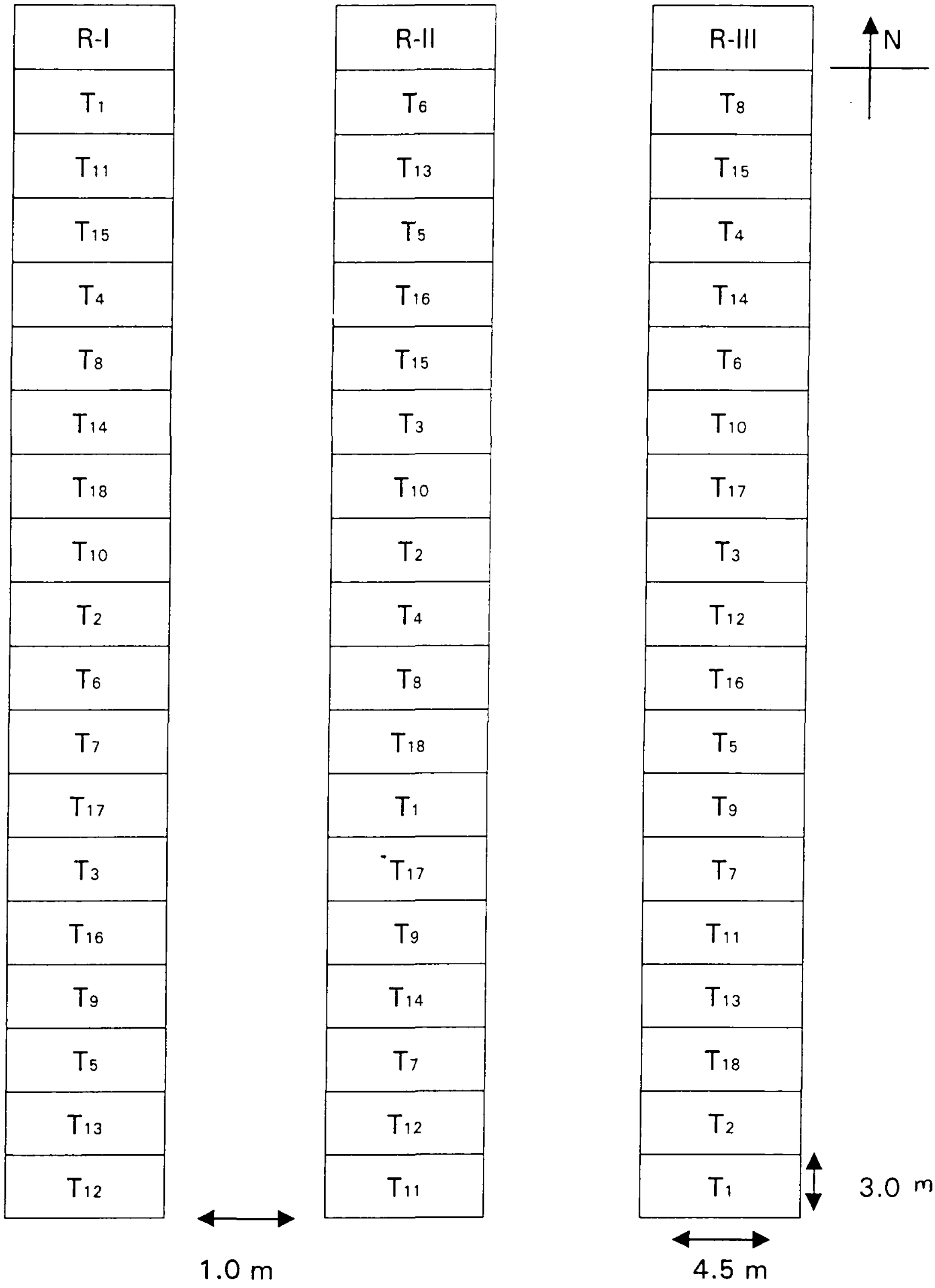


**Fig. 2: Plan of Layout of the Experiment**

Salient features of blackgram genotypes used in the present investigation are furnished below.

| Genotypes | Salient features |
|---|---|
| TAU-1 | It is the recommended variety for agroclimatic zone –I of Karnataka. It matures in 80-90 days with the average plant height of 30 cm and 100 seed weight of 5.0 grams. Seed yield is 10-12 q $ha^{-1}$. |
| Manikya | It is recommended for intercropping and double cropping systems of zone-I of Karnataka. It is a short and compact statured variety, matures early (75-80 days). It has hastate type of leaves and immature pods are light green in colour with sparsely distributed hairs on pod surface with average 100 seed weight of 4.0 grams. The seed yield ranges from 8-10 q $ha^{-1}$. |
| K-3 | It is a selection from Kharagaon, recommended for the whole state. Variety matures in 90 days with semi spreading growth habit. Pods are straight with 3-4 cm length, black in color and hairy. The seeds are bold and black in colour. The potential seed yield ranges from 8-9 q $ha^{-1}$. |

## 3.7 Collection of experimental data

### 3.7.1 Growth characters

Five plants from the net plot were randomly selected and observations on growth characteristics were recorded at 30 and 60 days and at harvest.

#### 3.7.1.1 Plant height (cm)

The plant height from ground surface to the tip of the main stem was measured at 30 DAS, 60 DAS and at harvest. Average height of five plants randomly selected was expressed as plant height in centimeters.

#### 3.7.1.2 Number of leaves per plant

Number of trifoliate leaves were counted from five plants at 30 DAS, 60 DAS and their mean was recorded.

#### 3.7.1.3 Number of branches per plant

The number of branches per plant were counted from five tagged plants and their mean was recorded as number of branches per plant at 30 DAS, 60 DAS and at harvest.

#### 3.7.1.4 Leaf area

Leaf area was recorded by disc method as suggested by Vivekanandan *et al.* (1972). Fifty leaf discs of known size were taken using a cork borer from randomly selected fifty leaves from five plants. Both discs and remaining leaf blades were oven dried at 65 to 70°C and leaf area was calculated by the formula at different stages of crop growth.

$$LA = \frac{Wa \times A}{Wd}$$

Where LA = Leaf area ($dm^2$)

Wa = Weight of all leaves (including 50 discs weight in g)

Wd = Weight of 50 discs (g)

A = Area of the disc ($dm^2$)

**3.7.1.5 Leaf area index (LAI)**

Leaf area index was worked out by dividing the leaf area per plant by land area occupied by the plant and it is defined as assimilatory surface per unit area of land according to Sestak *et al.* (1971).

$$LAI = \frac{\text{Leaf area per plant } (dm^2)}{\text{Land area occupied by plant } (dm^2)}$$

**3.7.1.6 Dry matter production and distribution**

The five randomly selected plants from distributive sampling area were used to record dry matter production at different growth stages. The sampled plants were partitioned into leaves, stem and pods. The samples were dried at 70°C till they attained constant dry weight. Dry weight was recorded separately at each stage of crop growth. The dry matter accumulation in stem, leaves, pods and total dry matter production per plant were expressed in grams per plant.

**3.7.1.7 Days to 50 per cent flowering**

One meter crop row length was selected at random in each treatment for recording this observation. The days required for flowers to appear in 50 per cent of the plants in the selected row length was recorded and expressed in the text as days to 50 per cent flowering.

#### 3.7.1.8 Days to physiological maturity

The date on which 95 per cent of pods attained maturity in each treatment was recorded. The number of days taken from sowing to physiological maturity were recorded and expressed as days to physiological maturity.

### 3.7.2 Yield parameters

The plants selected for growth studies in each treatment were utilised at the time of harvest for recording the observations on the following yield components.

#### 3.7.2.1 Number of pods per plant

The pods of individual plants were counted and average of five plants was recorded as number of pods per plant.

#### 3.7.2.2 Number of seeds per pod

The number of seeds from all pods of the five plant were counted. Number of seeds per pod was worked out by dividing the total number of seeds by the total number of pods to obtain number of seeds per pod.

#### 3.7.2.3 Number of seeds per plant

Pods of five randomly selected plants were threshed carefully, number of seeds were recorded and the average number of seeds of five plants were expressed as number of seeds per plant.

#### 3.7.2.4 Average pod length

Pod length in centimeter (cm) was obtained by averaging the length of ten pods from each treatment randomly selected at the time of harvest.

#### 3.7.2.5 Seed weight per plant

The seed weight of five plants was recorded and average weight of five plants was recorded as seed weight per plant in grams.

#### 3.7.2.6 Thousand seed weight

From seed sample of each treatment, 1000 seeds were counted at random and weighed. The 1000 seed height was expressed in grams.

#### 3.7.2.7 Seed yield (kg/ha)

Seed yield per plot was recorded after threshing and winnowing the seeds from each net plot area. The seed yield $ha^{-1}$ was worked out and expressed in kg $ha^{-1}$.

#### 3.7.2.8 Haulm yield (kg/ha)

The yield of above ground dry matter per net plot at harvest was recorded after complete sun drying and haulm yield per ha was worked out by deducting the grain yield.

#### 3.7.2.9 Harvest index (%)

From the data of seed yield (kg $ha^{-1}$) and total dry matter yield (kg $ha^{-1}$) the harvest index was calculated by using the formula given by Donald (1962) and expressed in percentage.

$$HI\ (\%) = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

#### 3.7.2.10 Per day Productivity (kg ha$^{-1}$ day$^{-1}$)

The seed yield ha$^{-1}$ was divided by the number of days to maturity in all the genotypes to get the per day productivity.

$$\text{Per day productivity (kg ha}^{-1}\text{ day}^{-1}) = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Days to maturity}}$$

### 3.8 Economics

The price of inputs that were prevailing at the time of their use and market price of commodities were taken to work out the cost of cultivation and gross returns (Appendix III).

The net profit ha$^{-1}$ was calculated by deducting the cost of cultivation ha$^{-1}$ from the gross income ha$^{-1}$. Benefit cost ratio was worked out as under.

$$\text{B:C ratio} = \frac{\text{Net profit (Rs ha}^{-1})}{\text{Cost of cultivation (Rs ha}^{-1})}$$

### 3.9 Plant analysis

The seed and haulm samples collected at harvest were dried and ground separately in Willey mill and passed through a 40 mesh sieve. The seed and haulm samples were used for the estimation of nitrogen and phosphorus content.

#### 3.9.1 Estimation of nitrogen content

The total nitrogen content (%) in seed and haulm was estimated by mictro-kjeladhal method as outlined by Jackson (1973).

### 3.9.2 Estimation of phosphorus content

Phosphorus content in seed and haulm was determined by Vanadomolybdate yellow colour method using Spectrophotometer as described by Jackson (1973).

### 3.9.3 Nutrient uptake

The total uptake of nitrogen and phosphorus at harvest by blackgram was calculated by multiplying their biomass yield with their corresponding percentage of nitrogen and phosphorus and expressed as kg $ha^{-1}$.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{\% of nutrient concentration}}{100} \times \text{Biomass yield (kg ha}^{-1}\text{)}$$

## 3.10 Statistical analysis of data

The data collected from the experiment were analyzed statistically following procedure described by Gomez and Gomez (1984). The level of significance used in 'F' test was $p = 0.05$.

# Experimental Results

# IV. EXPERIMENTAL RESULTS

The results of a field experiment conducted to study the response of blackgram genotypes to dates of sowing and phosphorus levels on *Kharif*, 2001 under rainfed condition are presented in this chapter.

## 4.1 Growth parameters

### 4.1.1 Plant height (cm)

The data on plant height of blackgram as influened by blackgram genotypes, dates of sowing and phosphorus levels are presented in Table 3.

At 30 days, plant height differed significantly among blackgram genotypes. Significantly higher plant height was registered by K-3 (13.68 cm) over TAU-1 (12.64 cm) and Manikya (9.73 cm). Among the dates of sowing, the crop sown on $16^{th}$ June recorded significantly higher plant height (14.41 cm) over $1^{st}$ July (11.56 cm) and $16^{th}$ July (10.08 cm). No significant difference was observed in plant height between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$. None of the interaction effects were significant. However, K-3 sown on $16^{th}$ June with 75 Kg $P_2O_5$ $ha^{-1}$ registered maximum plant height (16.43 cm).

At 60 DAS, the plant height differed significantly among the blackgram genotypes. Significantly higher plant height was recorded by K-3 (29.83 cm) over TAU–1 (21.04 cm) and Manikya (14.34 cm). Among the dates of sowing, the blackgram sown on $16^{th}$ June registered significantly higher plant height (24.47 cm) over $1^{st}$ July (21.94 cm) and $16^{th}$ July (18.81 cm). Application either 50 kg or 75 kg $P_2O_5$ $ha^{-1}$ had no significant influence on plant height. All the interaction effects on the plant height of blackgram were not

Table 3. **Plant height (cm) of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 30 DAS | | | | | 60 DAS | | | | | At harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | |
| | | $D_1$ | $D_2$ | $D_3$ | Mean | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | **Mean** |
| $G_1$ | $P_1$ | 15.60 | 11.60 | 10.10 | **12.41** | **12.64** | 23.80 | 20.77 | 17.33 | **20.77** | **21.04** | 26.57 | 22.70 | 20.58 | **23.28** | **23.63** |
| | $P_2$ | 15.83 | 12.33 | 10.53 | **12.87** | | 24.27 | 21.40 | 18.27 | **21.31** | | 27.17 | 23.47 | 21.33 | **23.99** | |
| | **Mean** | **15.72** | **11.88** | **10.32** | | | **24.03** | **21.08** | **18.00** | | | **26.87** | **23.08** | **20.95** | | |
| $G_2$ | $P_1$ | 10.80 | 9.63 | 8.27 | **9.57** | **9.73** | 16.47 | 14.27 | 11.50 | **14.08** | **14.34** | 18.13 | 15.17 | 12.53 | **15.28** | **15.58** |
| | $P_2$ | 11.73 | 9.70 | 8.27 | **9.90** | | 16.93 | 14.98 | 11.93 | **14.61** | | 18.60 | 15.90 | 13.13 | **15.88** | |
| | **Mean** | **11.27** | **9.67** | **8.27** | | | **16.70** | **14.62** | **11.72** | | | **18.37** | **15.53** | **12.83** | | |
| $G_3$ | $P_1$ | 16.07 | 12.93 | 11.53 | **13.51** | **13.68** | 32.37 | 29.83 | 26.53 | **29.58** | **29.83** | 38.20 | 32.93 | 27.87 | **33.00** | **33.41** |
| | $P_2$ | 16.43 | 13.33 | 11.80 | **13.86** | | 32.97 | 30.40 | 26.87 | **30.08** | | 38.87 | 33.90 | 28.67 | **33.81** | |
| | **Mean** | **16.25** | **13.13** | **11.67** | | | **32.67** | **30.12** | **26.70** | | | **38.53** | **33.42** | **28.27** | | |
| Mean of $P_1$ | | 14.16 | 11.37 | 9.97 | **11.33** | | 24.21 | 21.62 | 18.59 | **21.47** | | 27.63 | 23.60 | 20.32 | **23.85** | |
| Mean of $P_2$ | | 14.67 | 11.76 | 10.20 | **12.21** | | 24.72 | 22.27 | 19.02 | **22.00** | | 28.21 | 24.42 | 21.04 | **24.56** | |
| **Mean** | | **14.41** | **11.56** | **10.08** | | | **24.47** | **21.94** | **18.81** | | | **27.92** | **24.01** | **20.68** | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) | At harvest SEm± | At harvest CD (0.05) |
|---|---|---|---|---|---|---|
| Genotype (G) | 0.31 | 0.88 | 0.45 | 1.29 | 0.57 | 1.63 |
| P level (P) | 0.25 | NS | 0.37 | NS | 0.46 | NS |
| Date of sowing (D) | 0.31 | 0.88 | 0.45 | 1.29 | 0.57 | 1.63 |
| G x P | 0.44 | NS | 0.64 | NS | 0.80 | NS |
| G x D | 0.53 | NS | 0.78 | NS | 0.98 | NS |
| P x D | 0.44 | NS | 0.64 | NS | 0.80 | NS |
| G x P x D | 0.75 | NS | 1.10 | NS | 1.39 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - $16^{th}$ June
$D_2$ - $1^{st}$ July
$D_3$ - $16^{th}$ July

significant. However, maximum plant height of 32.97 cm was recorded by K-3 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$.

At harvest, significantly higher plant height was recorded in K-3 (33.41 cm) over TAU–1 (23.63 cm) and Manikya (15.58 cm). The blackgram sown on 16th June recorded significantly higher plant height (27.92 cm) over 1st July (24.01 cm) and 16th July (20.68 cm). No significant difference was observed in plant height between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$. The interaction effects on plant height were not significant. However, K-3 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$ recorded maximum plant height (38.87cm).

**4.1.2 Number of trifoliate leaves plant$^{-1}$**

The data on number of trifoliate leaves plant$^{-1}$ as influenced by blackgram genotypes, dates of sowing and phosphorus levels at different crop growth stages are given in Table 4.

At 30 DAS, significantly higher number of trifoliate leaves plant$^{-1}$ was observed in K-3 (2.92) over TAU-1 (2.66) and Manikya (2.48). Among the different dates of sowing, blackgram sown on 16th June recorded significantly higher number of trifoliate leaves (3.07) followed by 1st July (2.72) and 16th July (2,26). Application of either 50 kg or 75 kg $P_2O_5$ $ha^{-1}$ had no significant influence on number of trifoliate leaves plant$^{-1}$. None of the interaction effects were found significant. However, maximum number of trifoliate leaves of 3.40 was recorded by K-3 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$.

At 60 DAS, the blackgram genotype, K-3 recorded significantly higher number of trifoliate leaves plant$^{-1}$ (11.56) over TAU-1 (8.72) and Manikya (6.54). The blackgram sown on 16th June recorded significantly higher number of trifoliate leaves plant$^{-1}$ (11.30) compared to rest of the sowing dates. No

**Table 4. Number of trifoliate leaves per plant of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 30 DAS | | | | | 60 DAS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | Mean | | $D_1$ | $D_2$ | $D_3$ | Mean | |
| $G_1$ | $P_1$ | 2.97 | 2.80 | 2.13 | **2.63** | **2.66** | 11.03 | 9.07 | 5.30 | **8.47** | **8.72** |
| | $P_2$ | 3.00 | 2.87 | 2.20 | **2.69** | | 11.63 | 9.60 | 5.67 | **8.97** | |
| | **Mean** | **2.98** | **2.83** | **2.17** | | | **11.33** | **9.33** | **5.48** | | |
| $G_2$ | $P_1$ | 2.83 | 2.40 | 2.13 | **2.46** | **2.48** | 8.53 | 6.07 | 4.07 | **6.36** | **6.54** |
| | $P_2$ | 2.90 | 2.43 | 2.17 | **2.50** | | 8.83 | 7.13 | 4.20 | **6.72** | |
| | **Mean** | **2.87** | **2.42** | **2.15** | | | **8.68** | **6.80** | **4.13** | | |
| $G_3$ | $P_1$ | 3.33 | 2.87 | 2.47 | **2.89** | **2.92** | 13.40 | 11.40 | 7.63 | **10.81** | **11.56** |
| | $P_2$ | 3.40 | 2.93 | 2.53 | **2.96** | | 14.37 | 11.60 | 8.53 | **11.50** | |
| | **Mean** | **3.37** | **2.90** | **2.50** | | | **13.88** | **11.50** | **8.08** | | |
| Mean of $P_1$ | | 3.04 | 2.69 | 2.24 | **2.66** | | 10.99 | 8.98 | 5.67 | **8.54** | |
| Mean of $P_2$ | | 3.10 | 2.74 | 2.30 | **2.72** | | 11.61 | 9.44 | 6.13 | **9.06** | |
| **Mean** | | **3.07** | **2.72** | **2.27** | | | **11.30** | **9.21** | **5.90** | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.05 | 0.13 | 0.25 | 0.71 |
| P level (P) | 0.04 | NS | 0.20 | NS |
| Date of sowing (D) | 0.05 | 0.13 | 0.25 | 0.71 |
| G x P | 0.64 | NS | 0.35 | NS |
| G x D | 0.08 | NS | 0.43 | NS |
| P x D | 0.06 | NS | 0.35 | NS |
| G x P x D | 0.11 | NS | 0.60 | NS |

$G_1$ - TAU-1; $G_2$ - Manikya; $G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha; $P_2$ - 75 kg $P_2O_5$/ha; NS - Non-significant

$D_1$ - 16th June; $D_2$ - 1st July; $D_3$ - 16th July significant difference was observed in the number of trifoliate leaves plant$^{-1}$ between 50 kg or 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant. However, K-3 sown on 16[th] June with 75 kg $P_2O_5$ ha$^{-1}$ recorded maximum number of trifoliate leaves (14.37).

### 4.1.3 Number of branches plant$^{-1}$

The data on number of branches plant$^{-1}$ as influenced by blackgram genotypes, dates of sowing and phosphorus levels at different crop growth stages are furnished in Table 5.

At 30 DAS, the blackgram genotype, K-3 recorded significantly higher number of branches plant$^{-1}$ (3.01) over TAU-1 (2.63) and was on par with that of Manikya (2.99). There was no significant difference in the number of branches plant$^{-1}$ among the dates of sowing and phosphorus levels. None of the interaction effects were found significant. However, maximum number of branches plant$^{-1}$ (3.23) was recorded by K-3 at early sowing in 16[th] June with 75 kg $P_2O_5$ ha$^{-1}$.

At 60 DAS, the blackgram genotype, K-3 recorded significantly higher number of branches plant$^{-1}$ (4.95) over TAU-1 (4.46) and was on par with that of Manikya (4.94). Blackgram sown on 16[th] June recorded significantly higher number of branches plant$^{-1}$ (5.52) than 1[st] July (4.64) and 16[th] July (4.18). No significant difference was observed in the number of branch plant$^{-1}$ between 50 kg or 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were significant. However, Manikya sown on 16[th] June with 75 kg $P_2O_5$ ha$^{-1}$ recorded higher number of branches plant$^{-1}$ (5.90).

At harvest the blackgram genotype K-3 recorded significantly higher number of branches plant$^{-1}$ (5.59) over TAU-1 (4.83) and was on par with that

**Table 5. Number of branches per plant of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 30 DAS | | | | | 60 DAS | | | | | At harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 2.67 | 2.67 | 2.53 | **2.62** | **2.63** | 5.33 | 4.17 | 3.70 | **4.40** | **4.46** | 5.63 | 4.80 | 3.90 | **4.78** | **4.83** |
| | $P_2$ | 2.76 | 2.73 | 2.43 | **2.64** | | 5.43 | 4.30 | 3.80 | **4.51** | | 5.73 | 4.90 | 4.00 | **4.88** | |
| | **Mean** | **2.72** | **2.70** | **2.48** | | | **5.38** | **4.23** | **3.75** | | | **5.68** | **4.85** | **3.95** | **4.83** | |
| $G_2$ | $P_1$ | 2.97 | 2.70 | 2.90 | **2.99** | **2.99** | 5.77 | 4.63 | 4.20 | **4.87** | **4.94** | 6.17 | 5.23 | 4.43 | **5.28** | **5.32** |
| | $P_2$ | 3.07 | 3.10 | 2.77 | **3.00** | | 5.90 | 4.80 | 4.33 | **5.01** | | 6.23 | 5.33 | 4.53 | **5.37** | |
| | **Mean** | **3.02** | **3.17** | **2.83** | | | **5.83** | **4.72** | **4.27** | | | **6.20** | **5.28** | **4.48** | | |
| $G_3$ | $P_1$ | 3.13 | 3.13 | 2.70 | **2.97** | **3.01** | 5.30 | 4.93 | 4.47 | **4.90** | **4.95** | 6.60 | 5.27 | 4.77 | **5.54** | **5.59** |
| | $P_2$ | 3.23 | 3.07 | 2.77 | **3.06** | | 5.40 | 5.03 | 4.57 | **5.00** | | 6.67 | 5.37 | 4.87 | **5.63** | |
| | **Mean** | **3.18** | **3.17** | **2.73** | | | **5.35** | **4.98** | **4.52** | | | **6.63** | **5.32** | **4.82** | | |
| Mean of $P_1$ | | 2.92 | 2.94 | 2.71 | **2.86** | | 5.47 | 4.58 | 4.12 | **4.72** | | 6.13 | 5.10 | 4.37 | **5.20** | |
| Mean of $P_2$ | | 3.02 | 3.02 | 2.66 | **2.90** | | 5.58 | 4.71 | 4.23 | **4.84** | | 6.21 | 5.20 | 4.47 | **5.29** | |
| **Mean** | | **2.97** | **2.98** | **2.68** | | | **5.52** | **4.64** | **4.18** | | | **6.17** | **5.15** | **4.42** | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) | At harvest SEm± | At harvest CD (0.05) |
|---|---|---|---|---|---|---|
| Genotype (G) | 0.11 | 0.31 | 0.10 | 0.27 | 0.10 | 0.28 |
| P level (P) | 0.09 | NS | 0.08 | NS | 0.08 | NS |
| Date of sowing (D) | 0.11 | NS | 0.10 | 0.27 | 0.10 | 0.28 |
| G x P | 0.15 | NS | 0.14 | NS | 0.14 | NS |
| G x D | 0.19 | NS | 0.17 | NS | 0.17 | NS |
| P x D | 0.15 | NS | 0.14 | NS | 0.14 | NS |
| G x P x D | 0.26 | NS | 0.23 | NS | 0.24 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

of Manikya (5.32). Early sowing on 16th June recorded significantly higher number of branches plant$^{-1}$ (6.17) over TAU-1 (5.15) and Manikya (4.42). Application of 50 kg or 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on the number of branches plant$^{-1}$. The interaction effects were not significant. However, K-3 sown on 16th June with 75 kg $P_2O_5$ ha$^{-1}$ recorded maximum number of branches (6.67) plant$^{-1}$.

**4.1.4 Leaf area plant$^{-1}$ (dm$^2$)**

The data on leaf area plant$^{-1}$ as influenced by blackgram genotypes, dates of sowing and phosphorus levels at different crop growth stages are presented in Table 6.

At 30 DAS, blackgram genotype, K-3 registered significantly higher leaf area (1.38 dm$^2$ plant$^{-1}$) over TAU-1 (1.12 dm$^2$ plant$^{-1}$) and Manikya (0.92 dm$^2$ plant$^{-1}$). Blackgram sown on 16th June had significantly higher leaf area (1.45 dm$^2$ plant$^{-1}$) over 1st July (1.14 dm$^2$ plant$^{-1}$) and 16th July (0.84 dm$^2$ plant$^{-1}$). No significant difference was observed on leaf area plant$^{-1}$ between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. The interaction effects were not significant. However, K-3 sown on 16th June with 75 kg $P_2O_5$ ha$^{-1}$ recorded higher leaf area (1.81 dm$^2$ plant$^{-1}$).

At 60 DAS, the blackgram genotype, K-3 recorded significantly higher, leaf area (7.41 dm$^2$ plant$^{-1}$) over TAU –1 (5.84 dm$^2$ plant$^{-1}$) and Manikya (4.49 dm$^2$ plant$^{-1}$). Blackgram sown on 16th June produced significantly higher leaf area (7.20 dm$^2$ plant$^{-1}$) than 1st July (5.94 dm$^2$ plant$^{-1}$) and 16th July (4.60 dm$^2$ plant$^{-1}$). Application of either 50 kg or 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on leaf area (dm$^2$ plant$^{-1}$). None of the interaction effects were found significant. However, K-3 sown on 16th June with 75 kg $P_2O_5$ ha$^{-1}$ registered higher leaf area (9.04 dm$^2$ plant$^{-1}$).

Table 6. Leaf area ($dm^2$/plant) of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels

| Treatments | | 30 DAS | | | | | 60 DAS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 1.43 | 1.07 | 0.74 | **1.08** | **1.12** | 7.76 | 5.45 | 4.06 | **5.76** | **5.84** |
| | $P_2$ | 1.51 | 1.17 | 0.80 | **1.16** | | 7.81 | 5.73 | 4.22 | **5.92** | |
| | **Mean** | **1.47** | **1.12** | **0.77** | | | **7.79** | **5.59** | **4.14** | | |
| $G_2$ | $P_1$ | 1.10 | 0.88 | 0.66 | **0.88** | **0.92** | 4.79 | 4.55 | 3.54 | **4.92** | **4.49** |
| | $P_2$ | 1.15 | 0.92 | 0.81 | **0.96** | | 5.04 | 4.75 | 4.25 | **4.68** | |
| | **Mean** | **1.13** | **0.90** | **0.74** | | | **4.91** | **4.65** | **3.89** | | |
| $G_3$ | $P_1$ | 1.71 | 1.34 | 0.99 | **1.34** | **1.38** | 8.75 | 7.44 | 5.66 | **7.28** | **7.41** |
| | $P_2$ | 1.81 | 1.42 | 1.04 | **1.42** | | 9.04 | 7.70 | 5.86 | **7.53** | |
| | **Mean** | **1.76** | **1.38** | **1.01** | | | **8.90** | **7.57** | **5.76** | | |
| Mean of $P_1$ | | 1.41 | 1.10 | 0.80 | **1.10** | | 7.10 | 5.81 | 4.42 | **5.78** | |
| Mean of $P_2$ | | 1.49 | 1.17 | 0.88 | **1.18** | | 7.30 | 6.06 | 4.78 | **6.04** | |
| **Mean** | | **1.45** | **1.14** | **0.84** | | | **7.20** | **5.94** | **4.60** | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.05 | 0.14 | 0.29 | 0.82 |
| P level (P) | 0.04 | NS | 0.23 | NS |
| Date of sowing (D) | 0.05 | 0.14 | 0.29 | 0.82 |
| G x P | 0.07 | NS | 0.40 | NS |
| G x D | 0.09 | NS | 0.40 | NS |
| P x D | 0.07 | NS | 0.40 | NS |
| G x P x D | 0.12 | NS | 0.70 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

### 4.1.5 Leaf area index (LAI)

The data on leaf area index (LAI) of blackgram genotypes as influenced by dates of sowing and phosphorus levels at different crop growth stages are presented in Table 7.

At 30 DAS, the blackgram genotype, K-3 recorded significantly higher leaf area index (0.46) over TAU-1 (0.37) and Manikya (0.31). Among, dates of sowing blackgram sown on 16$^{th}$ June registered significantly higher leaf area index (0.48) over 1$^{st}$ July (0.38) and 16$^{th}$ July (0.29). Application of either 50 kg or 75 kg $P_2O_5$ $ha^{-1}$ had no significant influence on leaf area index. The interaction effects were also not found significant. However, K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ $ha^{-1}$ recorded higher leaf area index (0.60).

At 60 DAS the leaf area index of blackgram genotype K-3 (2.47) was significantly higher than the TAU-1 (1.95) and Manikya (1.48). Blackgram sown on 16$^{th}$ June obtained significantly higher leaf area index (2.40) over by 1$^{st}$ July (1.99) and 16$^{th}$ July (1.50). There was no significant difference in leaf area index between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$. The interaction effects were not significant. However, K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ $ha^{-1}$ recorded the maximum leaf area index (3.01).

### 4.1.6 Dry matter production and distribution

#### 4.1.6.1 Dry matter accumulation in leaves (g $plant^{-1}$)

The data on dry matter accumulation in leaves of blackgram genotypes as influenced by dates of sowing and phosphorus levels at different crop growth stages are presented in Table 8.

**Table 7. Leaf area index (LAI) of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 30 DAS | | | | | 60 DAS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 0.48 | 0.36 | 0.25 | **0.36** | **0.37** | 2.59 | 1.82 | 1.36 | **1.92** | **1.95** |
| | $P_2$ | 0.50 | 0.39 | 0.25 | **0.38** | | 2.60 | 1.92 | 1.41 | **1.98** | |
| | **Mean** | **0.49** | **0.38** | **0.25** | | | **2.60** | **1.87** | **1.38** | | |
| $G_2$ | $P_1$ | 0.37 | 0.29 | 0.26 | **0.31** | **0.31** | 1.60 | 1.52 | 1.18 | **1.43** | **1.48** |
| | $P_2$ | 0.39 | 0.31 | 0.27 | **0.32** | | 1.68 | 1.63 | 1.26 | **1.53** | |
| | **Mean** | **0.38** | **0.30** | **0.27** | | | **1.64** | **1.68** | **1.22** | | |
| $G_3$ | $P_1$ | 0.57 | 0.45 | 0.33 | **0.45** | **0.46** | 2.92 | 2.48 | 1.89 | **2.43** | **2.47** |
| | $P_2$ | 0.60 | 0.47 | 0.35 | **0.47** | | 3.01 | 2.57 | 1.93 | **2.50** | |
| | **Mean** | **0.59** | **0.46** | **0.34** | | | **2.97** | **2.53** | **1.91** | | |
| Mean of $P_1$ | | 0.47 | 0.37 | 0.28 | **0.37** | | 2.37 | 1.94 | 1.48 | **1.93** | |
| Mean of $P_2$ | | 0.50 | 0.39 | 0.29 | **0.39** | | 2.43 | 2.04 | 1.53 | **2.00** | |
| **Mean** | | **0.48** | **0.38** | **0.29** | | | **2.40** | **1.99** | **1.50** | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.02 | 0.05 | 0.12 | 0.33 |
| P level (P) | 0.01 | NS | 0.10 | NS |
| Date of sowing (D) | 0.02 | 0.05 | 0.12 | 0.33 |
| G x P | 0.02 | NS | 0.16 | NS |
| G x D | 0.03 | NS | 0.20 | NS |
| P x D | 0.02 | NS | 0.16 | NS |
| G x P x D | 0.04 | NS | 0.29 | NS |

$G_1$ - TAU-1   $P_1$ - 50 kg $P_2O_5$/ha   $D_1$ - 16[th] June
$G_2$ - Manikya   $P_2$ - 75 kg $P_2O_5$/ha   $D_2$ - 1[st] July
$G_3$ - K-3   NS - Non-significant   $D_3$ - 16[th] July

**Table 8. Dry matter accumulation in leaves (g/plant) of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 30 DAS | | | | | 60 DAS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 0.72 | 0.54 | 0.37 | **0.54** | **0.56** | 3.93 | 2.76 | 2.06 | **2.92** | **2.96** |
| | $P_2$ | 0.76 | 0.59 | 0.38 | **0.58** | | 3.96 | 2.90 | 2.13 | **3.00** | |
| | **Mean** | **0.74** | **0.57** | **0.38** | | | **3.94** | **2.83** | **2.10** | | |
| $G_2$ | $P_1$ | 0.56 | 0.45 | 0.40 | **0.47** | **0.48** | 2.43 | 2.30 | 1.79 | **2.17** | **2.23** |
| | $P_2$ | 0.58 | 0.46 | 0.41 | **0.49** | | 2.55 | 2.40 | 1.81 | **2.26** | |
| | **Mean** | **0.57** | **0.45** | **0.40** | | | **2.49** | **2.35** | **1.80** | | |
| $G_3$ | $P_1$ | 0.86 | 0.68 | 0.50 | **0.68** | **0.70** | 4.43 | 3.77 | 2.87 | **3.69** | **3.75** |
| | $P_2$ | 0.92 | 0.72 | 0.52 | **0.72** | | 4.58 | 3.90 | 2.97 | **3.81** | |
| | **Mean** | **0.89** | **0.70** | **0.51** | | | **4.50** | **3.83** | **2.92** | | |
| Mean of $P_1$ | | 0.71 | 0.56 | 0.42 | **0.57** | | 3.60 | 2.94 | 2.24 | **2.93** | |
| Mean of $P_2$ | | 0.75 | 0.59 | 0.44 | **0.60** | | 3.69 | 3.07 | 2.30 | **3.02** | |
| **Mean** | | **0.73** | **0.57** | **0.43** | | | 3.65 | 3.01 | 2.27 | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.02 | 0.07 | 0.12 | 0.34 |
| P level (P) | 0.02 | NS | 0.10 | NS |
| Date of sowing (D) | 0.02 | 0.07 | 0.12 | 0.34 |
| G x P | 0.03 | NS | 0.17 | NS |
| G x D | 0.04 | NS | 0.21 | NS |
| P x D | 0.03 | NS | 0.17 | NS |
| G x P x D | 0.06 | NS | 0.29 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

At 30 DAS, the genotype K-3 recorded significantly higher dry matter accumulation in leaves (0.70 g plant$^{-1}$) over TAU-1 (0.56 g plant$^{-1}$) and Manikya (0.48 g plant$^{-1}$). Blackgram sown on 16$^{th}$ June registered significantly higher dry matter accumulation in leaves (0.73 g plant$^{-1}$) over 1$^{st}$ July (0.57 g plant$^{-1}$) and 16$^{th}$ July (0.43 g plant$^{-1}$). No significant difference was observed on dry matter accumulation in leaves between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant. However, K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$ recorded higher dry matter accumulation in leaves (0.92 g plant$^{-1}$).

At 60 DAS, blackgram genotype K-3 registered maximum dry matter accumulation in leaves (3.75 g plant$^{-1}$) followed by TAU-1 (2.96 g plant$^{-1}$) and Manikya (2.23 g plant$^{-1}$) and the difference were significant from each other. Early sowing of blackgram on 16$^{th}$ June recorded significantly higher dry matter accumulation in leaves (3.65 g plant$^{-1}$) over 1$^{st}$ July (3.01 g plant$^{-1}$) and 16$^{th}$ July (2.27 g plant$^{-1}$). Application of either 50 kg or 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on dry matter accumulation in leaves. All the interaction effects were not significant. However, the maximum dry matter accumulation in leaves (4.58 g plant$^{-1}$) was recorded by genotype K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$.

#### 4.1.6.2 Dry matter accumulation in stem (g plant$^{-1}$)

The data on dry matter accumulation in stem as influenced by blackgram genotypes, dates of sowing and phosphorous levels at different crop growth stages are furnished in Table 9.

At 30 DAS, significantly, higher dry matter accumulation in stem (0.36 g plant$^{-1}$) was recorded in K-3 over TAU-1 (0.30 g plant$^{-1}$) and Manikya (0.26 g plant$^{-1}$). Blackgram sown on 16$^{th}$ June registered significantly higher dry matter

**Table 9. Dry matter accumulation in stem (g/plant) of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 30 DAS | | | | | 60 DAS | | | | | At harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 0.36 | 0.28 | 0.22 | **0.29** | **0.30** | 2.55 | 2.15 | 1.96 | **2.22** | **2.27** | 4.34 | 3.41 | 2.81 | **3.52** | **3.58** |
| | $P_2$ | 0.37 | 0.29 | 0.24 | **0.30** | | 2.65 | 2.27 | 2.03 | **2.31** | | 4.41 | 3.59 | 2.93 | **3.64** | |
| | **Mean** | **0.37** | **0.29** | **0.23** | | | **2.60** | **2.21** | **1.99** | | | **4.38** | **3.50** | **2.87** | | |
| $G_2$ | $P_1$ | 0.28 | 0.26 | 0.23 | **0.26** | **0.26** | 1.96 | 1.70 | 1.44 | **1.70** | **1.73** | 3.32 | 2.80 | 2.38 | **2.83** | **2.92** |
| | $P_2$ | 0.29 | 0.27 | 0.24 | **0.27** | | 2.07 | 1.71 | 1.51 | **1.77** | | 3.50 | 2.96 | 2.58 | **3.02** | |
| | **Mean** | **0.29** | **0.27** | **0.24** | | | **2.02** | **1.71** | **1.48** | | | **3.41** | **2.88** | **2.48** | | |
| $G_3$ | $P_1$ | 0.40 | 0.36 | 0.31 | **0.36** | **0.36** | 3.58 | 3.29 | 2.93 | **3.27** | **3.31** | 6.16 | 5.61 | 5.23 | **5.66** | **5.71** |
| | $P_2$ | 0.41 | 0.37 | 0.32 | **0.37** | | 3.65 | 3.36 | 3.03 | **3.34** | | 6.23 | 5.73 | 5.30 | **5.76** | |
| | **Mean** | **0.40** | **0.36** | **0.32** | | | **3.62** | **3.32** | **2.98** | | | **6.20** | **5.67** | **5.27** | | |
| Mean of $P_1$ | | 0.35 | 0.30 | 0.26 | **0.30** | | 2.70 | 2.38 | 2.11 | **2.40** | | 4.61 | 3.94 | 3.47 | **4.01** | |
| Mean of $P_2$ | | 0.36 | 0.31 | 0.27 | **0.31** | | 2.79 | 2.45 | 2.19 | **2.47** | | 4.72 | 4.10 | 3.60 | **4.14** | |
| **Mean** | | **0.35** | **0.31** | **0.26** | | | **2.74** | **2.41** | **2.15** | | | **4.66** | **4.02** | **3.54** | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) | At harvest SEm± | At harvest CD (0.05) |
|---|---|---|---|---|---|---|
| Genotype (G) | 0.01 | 0.02 | 0.05 | 0.15 | 0.07 | 0.20 |
| P level (P) | 0.01 | NS | 0.04 | NS | 0.06 | NS |
| Date of sowing (D) | 0.01 | 0.02 | 0.05 | 0.15 | 0.07 | 0.20 |
| G x P | 0.01 | NS | 0.07 | NS | 0.10 | NS |
| G x D | 0.01 | NS | 0.09 | NS | 0.12 | NS |
| P x D | 0.01 | NS | 0.07 | NS | 0.10 | NS |
| G x P x D | 0.02 | NS | 0.12 | NS | 0.17 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

accumulation in stem (0.35 g plant$^{-1}$) over 1$^{st}$ July (0.31 g plant$^{-1}$) and 16$^{th}$ July (0.26 g plant$^{-1}$). No significant difference was observed in dry matter accumulation of in stem between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant. However, K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$ recorded maximum dry matter accumulation in stem (0.41 g plant$^{-1}$).

At 60 DAS, the blackgram genotype, K-3 recorded maximum dry matter accumulation in stem (3.31 g plant$^{-1}$) followed by TAU-1 (2.27 g plant$^{-1}$) and Manikya (1.73 g plant$^{-1}$) and the difference were significant. Blackgram sown on 16$^{th}$ June recorded significantly higher dry matter accumulation in stem (2.74 g plant$^{-1}$) over 1$^{st}$ July (2.41 g plant$^{-1}$) and 16$^{th}$July (2.15 g plant$^{-1}$). Application of either 50 kg or 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on dry matter accumulation in stem. The interaction effects were not significant. However, maximum dry matter accumulation in stem (3.65 g plant$^{-1}$) was recorded by the genotype K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$.

At harvest, the blackgram genotype, K-3 recorded significantly higher dry matter accumulation in stem (5.71 g plant$^{-1}$) over TAU-1 (3.58 g plant$^{-1}$) and Manikya (2.92 g plant$^{-1}$). Early sowing of blackgram on 16$^{th}$ June registered significantly higher dry matter accumulation in stem (4.66 g plant$^{-1}$) over 1$^{st}$ July (4.02 g plant$^{-1}$) and 16$^{th}$ July (3.54 g plant$^{-1}$). There was no significant difference in dry matter accumulation in stem between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant. However, K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$ recorded maximum dry matter accumulation in stem. (6.23 g plant$^{-1}$).

#### 4.1.6.3 Dry matter accumulation in pods (g plant$^{-1}$)

The data on dry matter accumulation in pods of blackgram genotypes as influenced by dates of sowing and phosphorus levels at different crop growth stages are presented in Table 10 and depicted in Fig. 3 and 4.

At 60 DAS, the blackgram genotype TAU-1 recorded significantly higher dry matter accumulation in pods (2.47 g plant$^{-1}$) over K-3 (2.01 g plant$^{-1}$) and was on par with that of Manikya (2.41 g plant$^{-1}$). Among dates of sowing the blackgram sown on 16$^{th}$ June registered significantly highest dry matter accumulation in pods (2.66 g plant$^{-1}$) over 1$^{st}$ July (2.28 g plant$^{-1}$) and 16$^{th}$ July (1.95 g plant$^{-1}$). No significant difference was observed in dry matter accumulation in pods between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant. However, maximum dry matter accumulation in pods (3.00 g plant$^{-1}$) was recorded by genotype Manikya sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$.

At harvest, blackgram genotype TAU-1 registered significantly higher dry matter accumulation in pods (5.76 g plant$^{-1}$) over K-3 (4.56 g plant$^{-1}$) and was on par with that of Manikya (5.35 g plant$^{-1}$). Early sowing of blackgram on 16$^{th}$ June recorded significantly higher dry matter accumulation in pods (5.70 g plant$^{-1}$ ) over on 16$^{th}$ July (4.69 g plant$^{-1}$) and was on par with that of 1$^{st}$ July (5.29 g plant$^{-1}$). No significant difference was observed in dry matter accumulation in pods between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. All the interaction effects were not significant. However, TAU-1 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$ recorded maximum dry matter accumulation in pods (6.26g plant$^{-1}$).

**Table 10. Dry matter accumulation in pods (g /plant) of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 60 DAS | | | | | At harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 2.71 | 2.44 | 2.15 | **2.43** | **2.47** | 6.16 | 5.79 | 5.21 | **5.72** | **5.76** |
| | $P_2$ | 2.83 | 2.48 | 2.19 | **2.50** | | 6.26 | 5.80 | 5.33 | **5.80** | |
| | **Mean** | **2.77** | **2.46** | **2.17** | | | **6.21** | **5.80** | **5.27** | | |
| $G_2$ | $P_1$ | 2.59 | 2.31 | 2.04 | **2.31** | **2.41** | 5.89 | 5.43 | 4.22 | **5.18** | **5.35** |
| | $P_2$ | 3.00 | 2.48 | 2.06 | **2.51** | | 6.01 | 5.53 | 5.03 | **5.52** | |
| | **Mean** | **2.80** | **2.40** | **2.05** | | | **5.95** | **5.48** | **4.63** | | |
| $G_3$ | $P_1$ | 2.32 | 1.96 | 1.55 | **1.94** | **2.01** | 4.88 | 4.53 | 4.06 | **4.49** | **4.56** |
| | $P_2$ | 2.48 | 2.01 | 1.73 | **2.07** | | 5.02 | 4.63 | 4.27 | **4.64** | |
| | **Mean** | **2.40** | **1.99** | **1.64** | | | **4.95** | **4.58** | **4.16** | | |
| Mean of $P_1$ | | 2.54 | 2.24 | 1.91 | **2.23** | | 5.64 | 5.25 | 4.50 | **5.13** | |
| Mean of $P_2$ | | 2.77 | 2.32 | 1.99 | **2.36** | | 5.76 | 5.32 | 4.88 | **5.32** | |
| **Mean** | | **2.66** | **2.28** | **1.95** | | | **5.70** | **5.29** | **4.69** | | |

| Sources | 60 DAS SEm± | 60 DAS CD (0.05) | At harvest SEm± | At harvest CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.10 | 0.29 | 0.16 | 0.44 |
| P level (P) | 0.08 | NS | 0.13 | NS |
| Date of sowing (D) | 0.10 | 0.29 | 0.16 | 0.44 |
| G x P | 0.14 | NS | 0.22 | NS |
| G x D | 0.18 | NS | 0.27 | NS |
| P x D | 0.14 | NS | 0.22 | NS |
| G x P x D | 0.25 | NS | 0.38 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

## Legend

| | | |
|---|---|---|
| **I** | - | **Genotypes** |
| | $G_1$ - | TAU-1 |
| | $G_2$ - | Manikya |
| | $G_3$ - | K-3 |
| **II** | - | **Dates of sowing** |
| | $D_1$ - | $16^{th}$ June |
| | $D_2$ - | $1^{st}$ July |
| | $D_3$ - | $16^{th}$ July |
| **III** | - | **Phosphorus levels** |
| | $P_1$ - | 50 kg $P_2O_5$ $ha^{-1}$ |
| | $P_2$ - | 75 kg $P_2O_5$ $ha^{-1}$ |

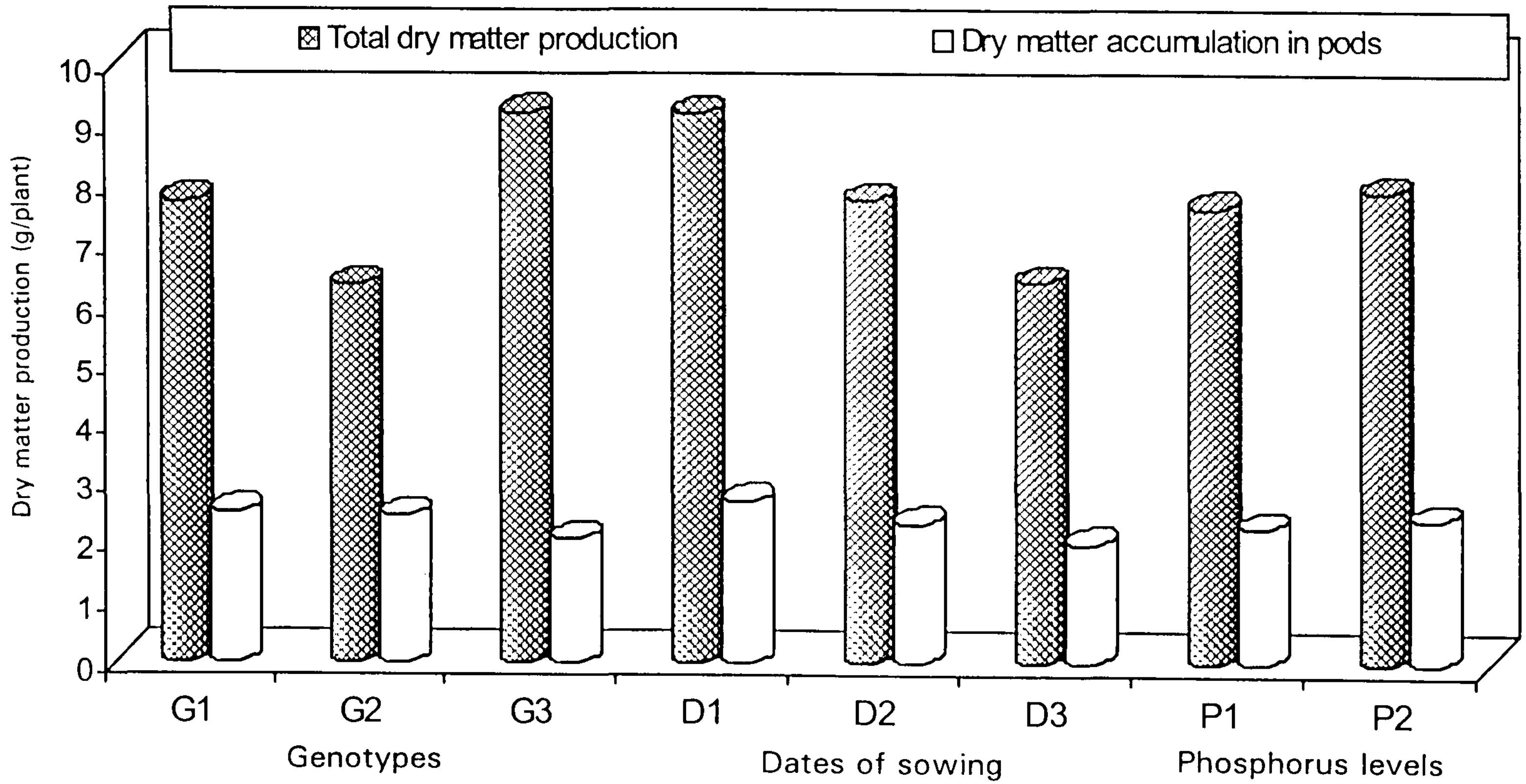


**Fig. 3. Total dry matter production and dry matter accumulation in pods at 60 DAS of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

## Legend

| | | |
|---|---|---|
| I | - | **Genotypes** |
| | $G_1$ - | TAU-1 |
| | $G_2$ - | Manikya |
| | $G_3$ - | K-3 |
| II | - | **Dates of sowing** |
| | $D_1$ - | $16^{th}$ June |
| | $D_2$ - | $1^{st}$ July |
| | $D_3$ - | $16^{th}$ July |
| III | - | **Phosphorus levels** |
| | $P_1$ - | 50 kg $P_2O_5$ $ha^{-1}$ |
| | $P_2$ - | 75 kg $P_2O_5$ $ha^{-1}$ |

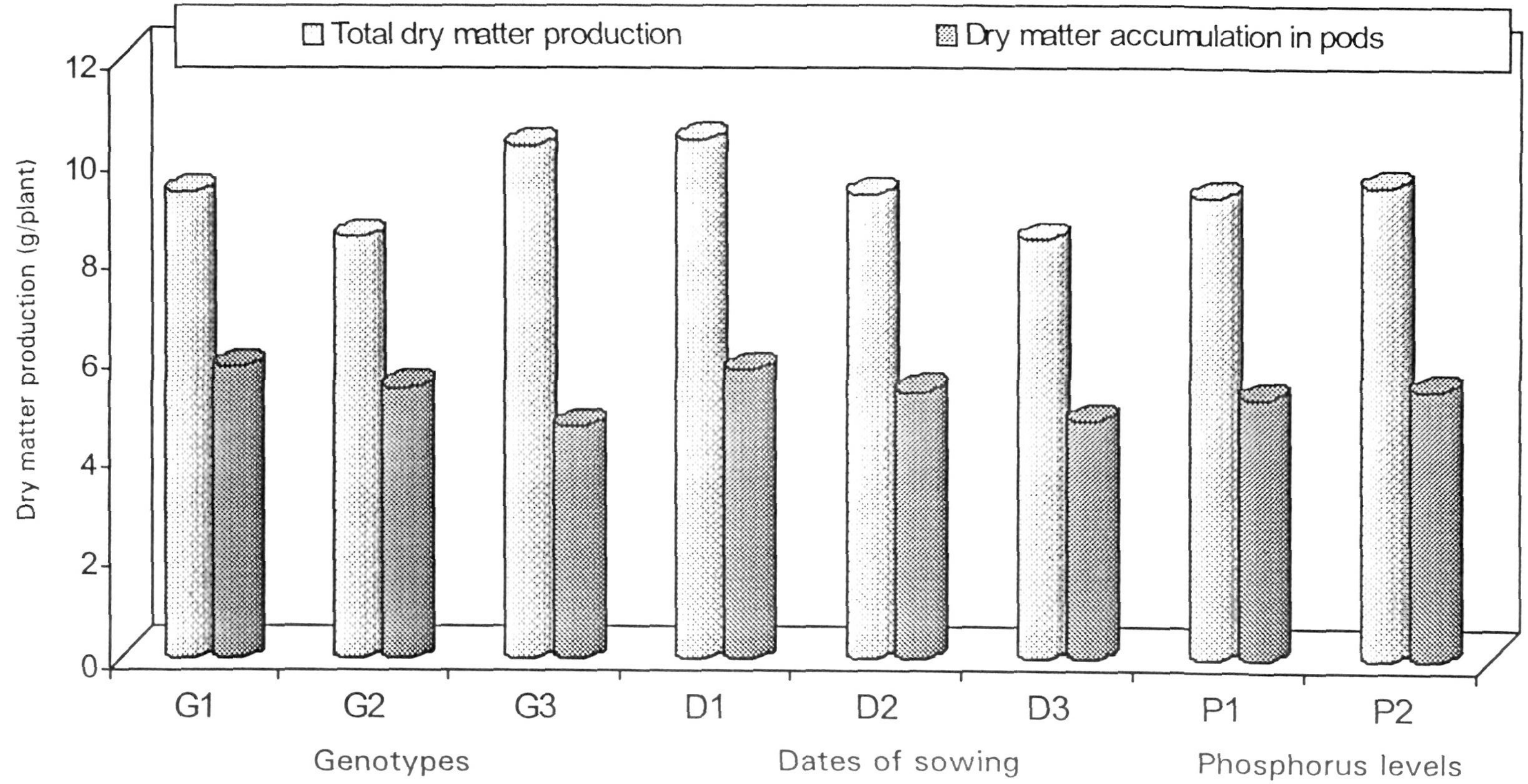


**Fig. 4. Total dry matter production and dry matter accumulation in pods at harvest of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

#### 4.1.6.4 Total dry matter production (g plant$^{-1}$)

The data on total dry matter production plant$^{-1}$ of blackgram genotypes as influenced by dates of sowing and phosphorus levels at different crop growth stages are furnished in Table 11 and depicted in Fig. 3 and 4.

At 30 DAS, the blackgram genotype K-3 recorded significantly higher total dry matter production (1.06 g plant$^{-1}$) over TAU-1 (0.86 g plant$^{-1}$) and Manikya (0.74 g plant$^{-1}$). Blackgram sown on 16$^{th}$ June produced significantly higher total dry matter production (1.09 g plant$^{-1}$) over 1$^{st}$ July (0.88 g plant$^{-1}$) and 16$^{th}$ July (0.69 g plant$^{-1}$). No significant difference was observed in total dry matter production of blackgram between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant. However maximum total dry matter production (1.32 g plant$^{-1}$) was recorded by genotype K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$.

At 60 DAS, the blackgram genotype K-3 produced significantly higher total dry matter production (9.18 g plant$^{-1}$) than TAU-1 (7.72 g plant$^{-1}$) and Manikya (6.34 g plant$^{-1}$). The crop sown on 16$^{th}$ June registered significantly higher total dry matter (9.14 g plant$^{-1}$) over 1$^{st}$ July (7.73 g plant$^{-1}$) and 16$^{th}$ July (6.37 g plant$^{-1}$). Application of either 50 kg or 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on total dry matter production plant$^{-1}$. The interaction effects were not found significant. However, K-3 sown on 16$^{th}$ June with 50 kg $P_2O_5$ ha$^{-1}$ recorded maximum total dry matter production (11.00 g plant$^{-1}$).

At harvest, the blackgram genotype K-3 produced significantly higher total dry matter (10.27 g plant$^{-1}$) over TAU-1 (9.33 g plant$^{-1}$) and Manikya (8.46 g plant$^{-1}$). The blackgram sown on 16$^{th}$ June recorded significantly higher total dry matter production (10.38 g plant$^{-1}$) over 1$^{st}$ July (9.29 g plant$^{-1}$)

**Table 11. Total dry matter production (g/plant) and its distribution of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | 30 DAS | | | | | 60 DAS | | | | | At harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | **Mean** |
| $G_1$ | $P_1$ | 1.08 | 0.83 | 0.60 | **0.84** | **0.86** | 9.19 | 7.35 | 6.16 | **7.57** | **7.72** | 10.51 | 9.20 | 8.02 | **9.24** | **9.33** |
| | $P_2$ | 1.13 | 0.89 | 0.62 | **0.88** | | 9.43 | 7.82 | 6.35 | **7.87** | | 10.67 | 9.31 | 8.26 | **9.41** | |
| | **Mean** | **1.11** | **0.86** | **0.61** | | | **9.31** | **7.59** | **6.26** | | | **10.59** | **9.25** | **8.14** | | |
| $G_2$ | $P_1$ | 0.84 | 0.71 | 0.63 | **0.73** | **0.74** | 6.88 | 6.31 | 5.27 | **6.15** | **6.34** | 9.22 | 8.23 | 7.60 | **8.35** | **8.46** |
| | $P_2$ | 0.88 | 0.73 | 0.65 | **0.75** | | 7.63 | 6.60 | 5.38 | **6.54** | | 9.60 | 8.49 | 7.61 | **8.57** | |
| | **Mean** | **0.86** | **0.72** | **0.64** | | | **7.25** | **6.45** | **5.35** | | | **9.41** | **8.36** | **7.61** | | |
| $G_3$ | $P_1$ | 1.26 | 1.04 | 0.82 | **1.04** | **1.06** | 11.00 | 9.01 | 7.35 | **9.12** | **9.18** | 11.01 | 10.14 | 9.28 | **10.14** | **10.27** |
| | $P_2$ | 1.32 | 1.09 | 0.85 | **1.09** | | 10.70 | 9.27 | 7.72 | **9.23** | | 11.25 | 10.36 | 9.57 | **10.40** | |
| | **Mean** | **1.29** | **1.06** | **0.83** | | | **10.85** | **9.14** | **7.53** | | | **11.13** | **10.25** | **9.43** | | |
| Mean of $P_1$ | | 1.06 | 0.86 | 0.68 | **0.87** | | 9.02 | 7.56 | 6.26 | **7.62** | | 10.25 | 9.19 | 8.30 | **9.25** | |
| Mean of $P_2$ | | 1.11 | 0.92 | 0.71 | **0.91** | | 9.25 | 7.89 | 6.48 | **7.88** | | 10.51 | 9.39 | 8.48 | **9.46** | |
| **Mean** | | **1.09** | **0.88** | **0.69** | | | **9.14** | **7.73** | **6.37** | | | **10.38** | **9.29** | **8.39** | | |

| Sources | 30 DAS SEm± | 30 DAS CD (0.05) | 60 DAS SEm± | 60 DAS CD (0.05) | At harvest SEm± | At harvest CD (0.05) |
|---|---|---|---|---|---|---|
| Genotype (G) | 0.03 | 0.09 | 0.19 | 0.54 | 0.20 | 0.56 |
| P level (P) | 0.02 | NS | 0.15 | NS | 0.16 | NS |
| Date of sowing (D) | 0.03 | 0.09 | 0.19 | 0.54 | 0.20 | 0.56 |
| G x P | 0.04 | NS | 0.26 | NS | 0.28 | NS |
| G x D | 0.05 | NS | 0.33 | NS | 0.34 | NS |
| P x D | 0.04 | NS | 0.27 | NS | 0.28 | NS |
| G x P x D | 0.07 | NS | 0.46 | NS | 0.48 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16$^{th}$ June
$D_2$ - 1$^{st}$ July
$D_3$ - 16$^{th}$ July

and $16^{th}$ July (8.39 g $plant^{-1}$). There was no significant difference in total dry matter production $plant^{-1}$ between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$. None of the interaction effects were found significant. However, maximum total dry matter production (11.25 g $plant^{-1}$) was recorded by genotype K-3 sown on $16^{th}$ June with 75 kg $P_2O_5$ $ha^{-1}$.

### 4.1.7 Days to 50 per cent flowering

The number of days taken to 50 per cent flowering in blackgram genotypes as influenced by the dates of sowing and phosphorus levels are furnished in Table 12.

The genotypes differed significantly with regard to number of days taken to reach 50 per cent flowering. Manikya took significantly more number of days (36.89) to reach 50 per cent flowering than TAU-1 (32.68) and was on par with that of K-3 (35.78).

The dates of sowing had significant influence on the number of days taken to 50 per cent flowering. The crop sown on $16^{th}$June took significantly more number of days to reach 50 per cent flowering (38.11 days) over $1^{st}$ July (35.28 days) and $16^{th}$ July (31.94 days).

The phosphorus levels had no significant influence on the days required to reach 50 per cent flowering by blackgram. All the interaction effects on the number of days taken to reach 50 per cent flowering were not significant.

### 4.1.8 Days to physiological maturity

The number of days taken to reach the physiological maturity in blackgram genotypes as influenced by the dates of sowing and phosphorous levels are presented in Table 12.

**Table 12. Days to 50 per cent flowering and physiological maturity of blackgram genotypes at different growth stages as influenced by dates of sowing and phosphorus levels**

| Treatments | | Days to 50% flowering | | | | | Physiological maturity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 35.33 | 32.33 | 29.33 | **32.33** | **32.68** | 66.00 | 64.00 | 57.33 | **62.44** | **62.67** |
| | $P_2$ | 36.00 | 33.00 | 30.00 | **33.00** | | 66.67 | 64.33 | 57.67 | **62.89** | |
| | **Mean** | **35.68** | **32.68** | **29.68** | | | **66.33** | **64.17** | **57.50** | | |
| $G_2$ | $P_1$ | 39.33 | 36.33 | 33.33 | **36.33** | **36.89** | 63.67 | 60.33 | 53.33 | **59.78** | **60.50** |
| | $P_2$ | 40.33 | 37.33 | 34.68 | **37.44** | | 65.67 | 61.67 | 56.33 | **61.22** | |
| | **Mean** | **39.83** | **36.83** | **34.00** | | | **64.67** | **61.00** | **55.83** | | |
| $G_3$ | $P_1$ | 38.68 | 35.68 | 31.68 | **35.33** | **35.78** | 78.00 | 74.33 | 69.00 | **73.78** | **74.77** |
| | $P_2$ | 39.00 | 37.00 | 32.68 | **36.22** | | 78.67 | 75.33 | 69.67 | **74.56** | |
| | **Mean** | **38.83** | **36.33** | **32.17** | | | **78.33** | **74.83** | **69.33** | | |
| Mean of $P_1$ | | 37.78 | 34.78 | 31.44 | **34.67** | | 69.22 | 66.22 | 60.56 | **65.33** | |
| Mean of $P_2$ | | 34.44 | 35.78 | 32.44 | **35.56** | | 70.33 | 67.11 | 61.22 | **66.22** | |
| **Mean** | | **38.11** | **35.28** | **31.94** | | | **69.78** | **66.67** | **60.89** | | |

| Sources | Days to 50% flowering SEm± | Days to 50% flowering CD (0.05) | Physiological maturity SEm± | Physiological maturity CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.46 | 1.33 | 0.84 | 2.41 |
| P level (P) | 0.38 | NS | 0.69 | NS |
| Date of sowing (D) | 0.46 | 1.33 | 0.84 | 2.41 |
| G x P | 0.65 | NS | 1.19 | NS |
| G x D | 0.80 | NS | 1.45 | NS |
| P x D | 0.65 | NS | 1.19 | NS |
| G x P x D | 1.13 | NS | 2.05 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

The genotypes differed significantly in the number of days taken to reach physiological maturity. The genotype K-3 took significantly more number of days (74.17) to reach physiological maturity than TAU-1 (62.67) and Manikya (60.50). However, TAU-1 and Manikya genotypes were on par with each other.

The dates of sowing caused significant influence on the number of days taken to physiological maturity by blackgram. The crop sown on 16$^{th}$June took significantly more number of days to reach physiological maturity (69.78) over blackgram sown on 1$^{st}$ July (66.67) and 16$^{th}$July (60.89).

There was no significant difference in physiological maturity between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$.

None of the interaction effects were found significant. However, K-3 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$ took maximum number of days to reach physiological maturity (78.67 days).

## 4.2 Yield components of blackgram

### 4.2.1 Number of pods per plant

The data on number of pods plant$^{-1}$ of blackgram genotypes as influenced by dates of sowing and phosphorus levels, are presented in Table 13. Manikya recorded significantly higher number of pods (15.91 plant$^{-1}$) over K-3 (13.80 plant$^{-1}$) and was on par with that of TAU-1 (15.80 plant$^{-1}$).

There was significant difference in the number of pods plant$^{-1}$ among different dates of sowing. Significantly higher number of pods (18.59 plant$^{-1}$) were recorded by early sowing on 16$^{th}$ June over 1$^{st}$ July (14.56 plant$^{-1}$) and 16$^{th}$ July (11.64 plant$^{-1}$).

**Table 13. Number of pods per plant and number of seeds per pod of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

| Treatments | | No. of pods / plant | | | | | No. of seeds / pod | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | Mean | | $D_1$ | $D_2$ | $D_3$ | Mean | |
| $G_1$ | $P_1$ | 18.53 | 13.80 | 12.27 | **14.87** | **15.08** | 5.20 | 4.95 | 4.80 | **4.98** | **5.01** |
| | $P_2$ | 18.84 | 14.17 | 12.87 | **15.29** | | 5.27 | 5.00 | 4.82 | **5.03** | |
| | **Mean** | **18.69** | **13.99** | **12.57** | | | **5.24** | **4.98** | **4.81** | | |
| $G_2$ | $P_1$ | 20.27 | 16.07 | 11.13 | **15.83** | **15.91** | 4.87 | 4.74 | 4.60 | **4.74** | **4.76** |
| | $P_2$ | 20.70 | 16.60 | 10.70 | **16.00** | | 4.93 | 4.75 | 4.64 | **4.78** | |
| | **Mean** | **20.49** | **16.34** | **10.92** | | | **4.91** | **4.75** | **4.62** | | |
| $G_3$ | $P_1$ | 16.20 | 13.10 | 11.20 | **13.50** | **13.80** | 4.97 | 4.83 | 4.52 | **4.77** | **4.85** |
| | $P_2$ | 16.97 | 13.63 | 11.67 | **14.09** | | 5.08 | 4.99 | 4.69 | **4.92** | |
| | **Mean** | **16.59** | **13.37** | **11.44** | | | **5.03** | **4.91** | **4.60** | | |
| Mean of $P_1$ | | 18.34 | 14.32 | 11.54 | **14.73** | | 5.01 | 4.84 | 4.64 | **4.83** | |
| Mean of $P_2$ | | 18.84 | 14.80 | 11.75 | **15.13** | | 5.09 | 4.91 | 4.72 | **4.91** | |
| **Mean** | | **18.59** | **14.56** | **11.64** | | | **5.05** | **4.88** | **4.68** | | |

| Sources | No. of pods / plant SEm± | No. of pods / plant CD (0.05) | No. of seeds / pod SEm± | No. of seeds / pod CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.49 | 1.40 | 0.08 | NS |
| P level (P) | 0.40 | NS | 0.07 | NS |
| Date of sowing (D) | 0.49 | 1.40 | 0.08 | 0.22 |
| G x P | 0.69 | NS | 0.11 | NS |
| G x D | 0.84 | NS | 0.14 | NS |
| P x D | 0.69 | NS | 0.11 | NS |
| G x P x D | 1.19 | NS | 0.20 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

No significant difference was observed in the number of pods plant$^{-1}$ between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$.

None of the interaction effects were significant. However, Manikya sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$ recorded maximum number of pods plant$^{-1}$ (20.70).

### 4.2.2 Number of seeds per pod

The data on number of seeds pod$^{-1}$ of blackgram genotypes as influenced by dates of sowing and phosphorus level are furnished in Table 13.

There was no significant difference between the blackgram genotypes. However, TAU-1 recorded maximum number of seeds pod$^{-1}$ (5.01).

There was significant difference in the number of seeds pod$^{-1}$ among different dates sowing. Maximum number of seeds (5.05 pod$^{-1}$) was recorded by early sowing in 16$^{th}$ June followed by 1$^{st}$ July (4.88 pod$^{-1}$) and 16$^{th}$ July (4.68 pod$^{-1}$).

No significant difference was observed in the number of seeds pod$^{-1}$ between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$.

None of the interaction effects were significant on the number of seeds pod$^{-1}$. However, the maximum number of seeds (5.27 pod$^{-1}$) was obtained in TAU-1 when sown on 16$^{th}$June with 75 kg $P_2O_5$ ha$^{-1}$.

### 4.2.3 Number of seeds plant$^{-1}$

The data on the number of seeds plant$^{-1}$ of blackgram genotypes as influenced by dates of sowing and phosphorus levels are given in Table 14.

**Table 14. Number of seeds per plant and average pod length (cm) of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

| Treatments | | No. of seeds / plant | | | | | Average pod length (cm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 96.70 | 68.23 | 58.79 | **74.57** | **75.98** | 4.78 | 4.75 | 4.61 | **4.72** | **4.69** |
| | $P_2$ | 99.45 | 70.93 | 61.79 | **77.39** | | 4.79 | 4.73 | 4.50 | **4.67** | |
| | **Mean** | **98.07** | **69.58** | **60.29** | | | **4.79** | **4.74** | **4.56** | | |
| $G_2$ | $P_1$ | 97.90 | 76.49 | 51.24 | **75.21** | **75.87** | 4.53 | 4.30 | 4.46 | **4.43** | **4.41** |
| | $P_2$ | 101.11 | 78.84 | 49.62 | **76.52** | | 4.54 | 4.33 | 4.28 | **4.38** | |
| | **Mean** | **99.51** | **77.65** | **50.43** | | | **4.53** | **4.31** | **4.37** | | |
| $G_3$ | $P_1$ | 80.21 | 63.77 | 50.62 | **64.80** | **67.28** | 5.32 | 4.93 | 4.72 | **4.99** | **4.96** |
| | $P_2$ | 85.49 | 67.91 | 55.87 | **69.75** | | 5.21 | 4.74 | 4.86 | **4.93** | |
| | **Mean** | **82.75** | **65.84** | **53.24** | | | **5.26** | **4.83** | **4.79** | | |
| Mean of $P_1$ | | 91.54 | 69.50 | 53.55 | **71.53** | | 4.88 | 4.66 | 4.60 | **4.71** | |
| Mean of $P_2$ | | 95.35 | 72.56 | 55.76 | **74.55** | | 4.85 | 4.60 | 4.55 | **4.66** | |
| **Mean** | | **93.44** | **71.03** | **54.64** | | | **4.86** | **4.63** | **4.57** | | |

| Sources | SEm± | CD (0.05) | SEm± | CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 2.41 | 6.93 | 0.07 | 0.20 |
| P level (P) | 1.97 | NS | 0.06 | NS |
| Date of sowing (D) | 2.41 | 6.93 | 0.07 | 0.20 |
| G x P | 3.41 | NS | 0.10 | NS |
| G x D | 4.18 | NS | 0.12 | NS |
| P x D | 3.41 | NS | 0.10 | NS |
| G x P x D | 5.91 | NS | 0.17 | NS |

$G_1$ - TAU-1　　$P_1$ - 50 kg $P_2O_5$/ha　　$D_1$ - 16th June
$G_2$ - Manikya　　$P_2$ - 75 kg $P_2O_5$/ha　　$D_2$ - 1st July
$G_3$ - K-3　　NS - Non-significant　　$D_3$ - 16th July

Genotype TAU-1 recorded significantly higher number of seeds $plant^{-1}$ (75.98) over K-3 (67.28 $plant^{-1}$) and was on par with that of Manikya (75.87 $plant^{-1}$).

Among the different dates of sowing, 16$^{th}$ June obtained significantly higher number of seeds (93.44 $plant^{-1}$) over 1$^{st}$ July (71.03 $plant^{-1}$) and 16$^{th}$ July (54.64 $plant^{-1}$).

There was no significant difference in the number of seeds $plant^{-1}$ between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$.

All of the interaction effects were not found significant. However, Manikya sown on 16$^{th}$ June with 75 kg $P_2O_5$ $ha^{-1}$ recorded maximum number of seeds (101.12 $plant^{-1}$).

### 4.2.4 Average pod length (cm)

The data recorded on average pod length (cm) of blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table14. Genotype K-3 recorded significantly higher pod length (4.96 cm) over Manikya (4.41 cm) and TAU-1 (4.69 cm).

Among the different dates of sowing, 16$^{th}$ June recorded significantly higher average pod length (4.86 cm) over 1$^{st}$ July (4.63 cm) and 16$^{th}$ July (4.57 cm). However, blackgram sown on 1$^{st}$ July and 16$^{th}$ July recorded statistically on par average pod length.

No significant difference was obtained in average pod length between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$.

None of the interaction effects were found significant. However K-3 sown on 16th June with 50 kg $P_2O_5$ $ha^{-1}$ recorded maximum average pod length (5.32 cm ).

#### 4.2.5 Grain weight (g $plant^{-1}$)

The data on grain weight $plant^{-1}$ (g) of blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table 15. Among the different blackgram genotypes, TAU-1 recorded significantly higher grain weight (3.12 g $plant^{-1}$) over Manikya (2.77 g $plant^{-1}$) and K-3 (2.66 g $plant^{-1}$). However, Manikya and K-3 genotypes recorded on par grain weight $plant^{-1}$.

There was significant difference in grain weight $plant^{-1}$ among different dates of sowing. Maximum grain weight (3.98 g $plant^{-1}$) was registered by early sowing in 16th June followed by 1st July (2.72 g $plant^{-1}$) and 16th July (1.85 g $plant^{-1}$).

Application of either 50 kg or 75 kg $P_2O_5$ $ha^{-1}$ had no significant influence on grain weight $plant^{-1}$.

None of the interaction effects were significant. However, TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$ obtained maximum grain weight (4.63 g $plant^{-1}$).

#### 4.2.6 Thousand grain weight

The data on thousand grain weight (g) of blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table 15. Genotype TAU-1 recorded significantly higher 1000 grain weight (40.18 g) over Manikya (35.57 g) and was on par with that of K-3 (39.91 g).

**Table 15. Seed weight per plant (g) and 1000 seed weight (g) of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

| Treatments | | Seed weight/plant (g) | | | | | 1000 seed weight (g) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 4.36 | 2.68 | 2.02 | **3.02** | **3.12** | 45.27 | 39.54 | 34.77 | **39.86** | **40.18** |
| | $P_2$ | 4.63 | 2.88 | 2.17 | **3.22** | | 46.20 | 40.10 | 35.21 | **40.51** | |
| | **Mean** | **4.49** | **2.78** | **2.10** | | | **45.74** | **39.82** | **34.99** | | |
| $G_2$ | $P_1$ | 3.81 | 2.67 | 1.68 | **2.72** | **2.77** | 38.92 | 34.60 | 32.64 | **35.39** | **35.57** |
| | $P_2$ | 3.95 | 2.80 | 1.69 | **2.81** | | 39.12 | 35.2 | 32.92 | **35.75** | |
| | **Mean** | **3.88** | **2.74** | **1.69** | | | **39.02** | **34.90** | **32.78** | | |
| $G_3$ | $P_1$ | 3.50 | 2.59 | 1.72 | **2.60** | **2.66** | 44.10 | 40.80 | 33.92 | **39.61** | **39.91** |
| | $P_2$ | 3.65 | 2.71 | 1.80 | **2.72** | | 45.14 | 41.26 | 34.20 | **40.20** | |
| | **Mean** | **3.68** | **2.70** | **1.81** | | | **44.62** | **41.03** | **34.06** | | |
| Mean of $P_1$ | | 3.89 | 2.64 | 1.81 | **2.78** | | 42.76 | 38.31 | 33.78 | **38.28** | |
| Mean of $P_2$ | | 4.07 | 2.79 | 1.89 | **2.95** | | 43.49 | 38.85 | 34.11 | **38.82** | |
| **Mean** | | **3.48** | **2.72** | **1.85** | | | **43.13** | **38.58** | **33.94** | | |

| Sources | Seed weight/plant SEm± | Seed weight/plant CD (0.05) | 1000 seed weight SEm± | 1000 seed weight CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.11 | 0.31 | 0.69 | 1.97 |
| P level (P) | 0.09 | NS | 0.56 | NS |
| Date of sowing (D) | 0.11 | 0.31 | 0.69 | 1.97 |
| G x P | 0.15 | NS | 0.97 | NS |
| G x D | 0.19 | NS | 1.19 | NS |
| P x D | 1.15 | NS | 0.97 | NS |
| G x P x D | 0.26 | NS | 1.68 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

Significantly higher 1000 grain weight (43.13 g) was recorded by early sowing in 16th June over 1st July (38.58 g) and 16th July (33.94 g).

Application of either 50 kg or 75 kg $P_2O_5$ $ha^{-1}$ had no significant influence on 1000 grain weight.

There was no significant influence of all the interaction effects on 1000 grain weight of blackgram. However, the maximum 1000 grain weight of blackgram (46.20 g) was recorded by genotypes TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$.

**4.2.7 Seed Yield (kg $ha^{-1}$)**

The data on seed yield of blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table 16 and depicted in Fig. 5.

Genotype, TAU-1 recorded significantly higher seed yield (845.41 kg $ha^{-1}$) over K-3 (690.77 kg $ha^{-1}$) and Manikya (765.86 kg $ha^{-1}$).

There was significant difference in seed yield among different dates of sowing. Maximum seed yield was obtained by early sowing in 16th June (1068.87 kg $ha^{-1}$) followed by 1st July (741.93 kg $ha^{-1}$) and 16th July (491.24 kg $ha^{-1}$).

No significant difference was observed in seed yield between 50 kg or 75 kg $P_2O_5$ $ha^{-1}$.

None of the interaction effects were significant. However, TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$ recorded maximum seed yield (1201.62 kg $ha^{-1}$).

**Table 16. Seed yield (kg/ha) and haulm yield (kg/ha) of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

| Treatments | | Seed yield (kg/ha) | | | | | Haulm yield (kg/ha) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 1182.13 | 746.36 | 562.31 | **830.27** | **845.41** | 1651.13 | 1414.14 | 1150.49 | **1405.25** | **1393.05** |
| | $P_2$ | 1201.62 | 82.1.15 | 558.87 | **860.55** | | 1659.83 | 1400.91 | 1081.78 | **1380.84** | |
| | **Mean** | **1191.88** | **783.76** | **560.59** | | | **1655.48** | **1407.53** | **1116.14** | | |
| $G_2$ | $P_1$ | 1042.71 | 723.18 | 489.81 | **751.90** | **765.86** | 1433.57 | 1169.39 | 1006.79 | **1203.25** | **1209.75** |
| | $P_2$ | 1069.69 | 751.00 | 518.79 | **779.82** | | 1449.68 | 1128.90 | 1020.20 | **1216.26** | |
| | **Mean** | **1156.20** | **737.09** | **504.30** | | | **1441.62** | **1149.15** | **1013.50** | | |
| $G_3$ | $P_1$ | 909.20 | 692.32 | 401.28 | **667.60** | **690.77** | 2331.00 | 2008.55 | 1614.16 | **1984.57** | **2018.92** |
| | $P_2$ | 1007.87 | 717.56 | 416.36 | **713.93** | | 2361.07 | 2211.65 | 1587.11 | **2053.28** | |
| | **Mean** | **958.54** | **704.94** | **408.82** | **690.77** | | **2346.04** | **2110.10** | **1600.64** | | |
| Mean of $P_1$ | | 1044.68 | 720.62 | 484.47 | **749.92** | | 1805.23 | 1530.69 | 1257.15 | **1531.02** | |
| Mean of $P_2$ | | 1093.06 | 763.24 | 498.01 | **784.77** | | 1823.53 | 1580.49 | 1229.70 | **1544.57** | |
| **Mean** | | **1068.87** | **741.93** | **491.24** | | | **1814.38** | **1555.59** | **1243.42** | | |

| Sources | Seed yield SEm± | Seed yield CD (0.05) | Haulm yield SEm± | Haulm yield CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 17.19 | 49.40 | 40.91 | 117.57 |
| P level (P) | 14.03 | NS | 33.40 | NS |
| Date of sowing (D) | 17.19 | 49.40 | 40.91 | 117.57 |
| G x P | 24.31 | NS | 57.85 | NS |
| G x D | 29.77 | NS | 70.86 | NS |
| P x D | 24.31 | NS | 57.85 | NS |
| G x P x D | 42.10 | NS | 100.21 | NS |

$G_1$ - TAU-1; $G_2$ - Manikya; $G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha; $P_2$ - 75 kg $P_2O_5$/ha; NS - Non-significant

$D_1$ - 16th June; $D_2$ - 1st July; $D_3$ - 16th July

## Legend

| | | |
|---|---|---|
| I | - | **Genotypes** |
| | $G_1$ - | TAU-1 |
| | $G_2$ - | Manikya |
| | $G_3$ - | K-3 |
| II | - | **Dates of sowing** |
| | $D_1$ - | 16th June |
| | $D_2$ - | 1st July |
| | $D_3$ - | 16th July |
| III | - | **Phosphorus levels** |
| | $P_1$ - | 50 kg $P_2O_5$ $ha^{-1}$ |
| | $P_2$ - | 75 kg $P_2O_5$ $ha^{-1}$ |

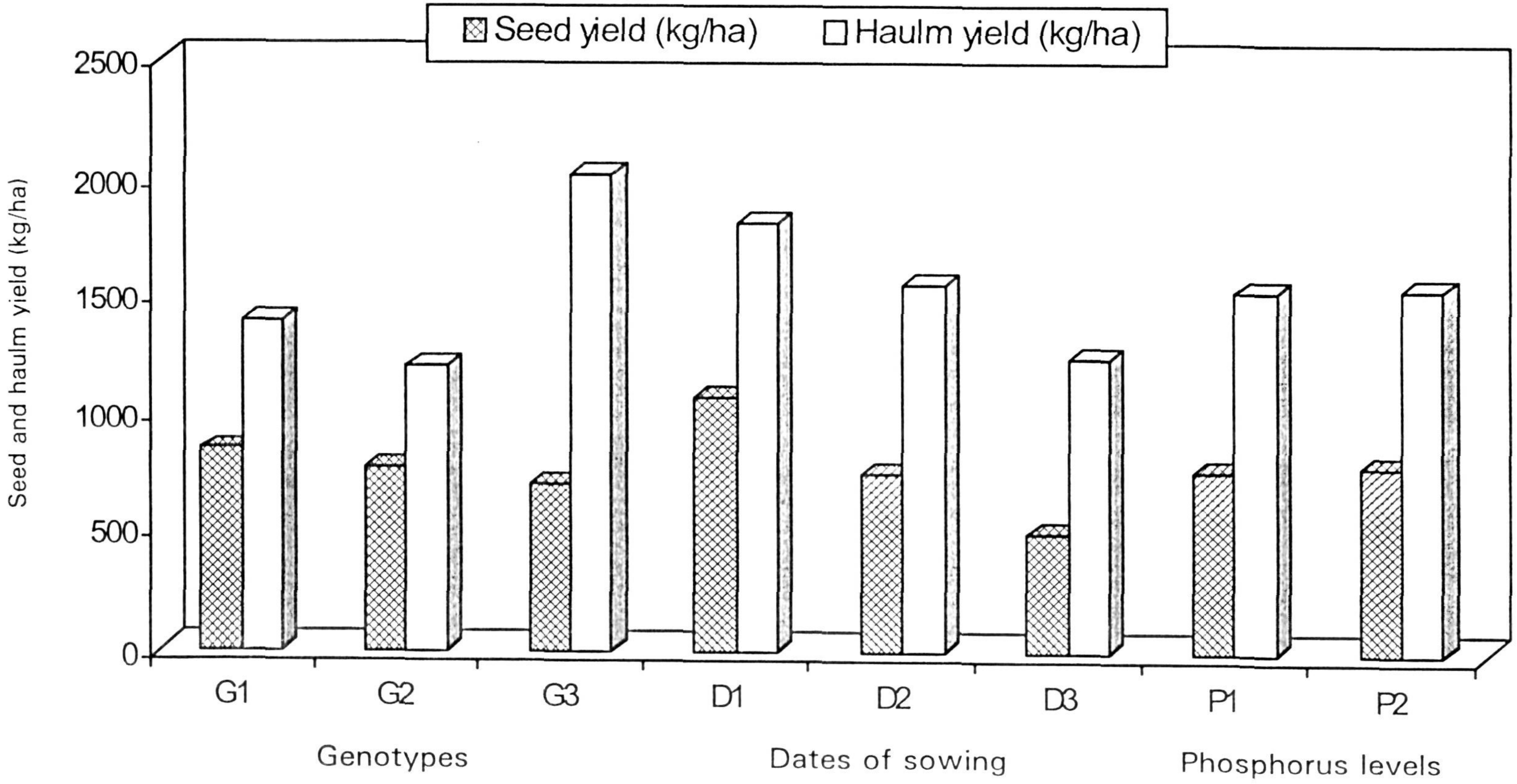


**Fig. 5. Seed and haulm yield of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

### 4.2.8 Haulm yield (kg $ha^{-1}$)

The data recorded on haulm yield c, blackgram genotypes as influenced by dates of sowing and phosphorus levels are furnished in Table 16 and depicted in Fig. 5. Genotype, K-3 obtained significantly higher haulm yield (2018.92 kg $ha^{-1}$) over TAU-1 (1393.05 kg $ha^{-1}$) and Manikya (1209.42 kg $ha^{-1}$).

Blackgram sown on $16^{th}$ June recorded significantly higher haulm yield (1814.38 kg $ha^{-1}$) over $1^{st}$ July (1555.59 kg $ha^{-1}$) and $16^{th}$ July (1243.42 kg $ha^{-1}$).

Application of either 50 kg or 75 kg $P_2O_5$ $ha^{-1}$ had no significant influence on haulm yield of blackgram.

All the interaction effects were not found significant. However, K-3 sown on $16^{th}$ June with 75 kg $P_2O_5$ $ha^{-1}$ registered maximum haulm yield (2361.07 kg $ha^{-1}$).

### 4.2.9 Harvest index (%)

The data on harvest index of blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table 17. Blackgram genotype Manikya recorded significantly higher harvest index (38.02%) over K-3 (25.43 %) and was on par with that of TAU-1 (37.12%).

Significantly higher harvest index (38.05%) of blackgram was obtaining by early sowing on $16^{th}$ June over $1^{st}$ July (33.46%) and $16^{th}$ July (29.06%).

No significant difference was observed in harvest index of blackgram between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$.

**Table 17. Harvest index (%) and per day productivity (kg/ha/day) of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

| Treatments | | Harvest index (%) | | | | | Per day productivity (kg/ha/day) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 41.90 | 34.83 | 32.87 | **36.53** | **37.12** | 13.91 | 8.78 | 6.61 | **9.76** | **9.94** |
| | $P_2$ | 42.00 | 37.10 | 34.03 | **37.71** | | 14.13 | 9.66 | 6.57 | **10.12** | |
| | **Mean** | **41.95** | **35.97** | **33.45** | | | **14.01** | **9.22** | **6.59** | | |
| $G_2$ | $P_1$ | 42.34 | 38.23 | 32.83 | **37.80** | **38.02** | 12.55 | 9.64 | 6.53 | **9.58** | **9.77** |
| | $P_2$ | 42.44 | 38.93 | 33.90 | **38.24** | | 12.93 | 10.01 | 6.92 | **9.95** | |
| | **Mean** | **42.60** | **38.30** | **33.37** | | | **12.74** | **9.83** | **6.73** | | |
| $G_3$ | $P_1$ | 29.70 | 26.73 | 19.93 | **25.45** | **25.43** | 10.10 | 7.69 | 4.46 | **7.42** | **7.68** |
| | $P_2$ | 29.90 | 25.50 | 20.80 | **25.40** | | 11.20 | 7.97 | 4.63 | **7.93** | |
| | **Mean** | **29.80** | **26.12** | **20.37** | | | **10.65** | **7.83** | **4.54** | | |
| Mean of $P_1$ | | 37.98 | 33.26 | 28.54 | **33.49** | | 12.19 | 8.71 | 5.86 | **8.92** | |
| Mean of $P_2$ | | 38.11 | 33.66 | 29.58 | **33.67** | | 12.75 | 9.22 | 6.04 | **9.34** | |
| **Mean** | | **38.05** | **33.46** | **29.06** | | | **12.47** | **8.96** | **5.95** | | |

| Sources | SEm± | CD (0.05) | SEm± | CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.99 | 2.85 | 0.21 | 0.61 |
| P level (P) | 0.81 | NS | 0.17 | NS |
| Date of sowing (D) | 0.99 | 2.85 | 0.21 | 0.61 |
| G x P | 1.40 | NS | 0.30 | NS |
| G x D | 1.72 | NS | 0.37 | NS |
| P x D | 1.40 | NS | 0.30 | NS |
| G x P x D | 2.43 | NS | 5.21 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

None of the interaction effects were significant. However, Manikya sown on 16th June with 75 kg $P_2O_5$ ha$^{-1}$ obtained maximum harvest index (42.44%).

### 4.2.10 Per day productivity (kg/ha/day)

The data on per day productivity of blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table 17. Genotype TAU-1 recorded significantly higher per day productivity (9.94 kg ha$^{-1}$ day$^{-1}$) over K-3 (7.68 kg ha$^{-1}$ day$^{-1}$) and was on par with that of Manikya (9.77 kg ha$^{-1}$ day$^{-1}$).

Among the dates of sowing, 16th June recorded significantly higher per day productivity (12.47 kg ha$^{-1}$ day$^{-1}$) over 1st July (8.96 kg ha$^{1}$ day$^{-1}$) and 16th July (5.95 kg ha$^{-1}$day$^{-1}$).

Application of either 50 kg or 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on per day productivity of blackgram.

None of the interaction effects were found significant. However, TAU-1 sown on 16th June with 75 kg $P_2O_5$ ha$^{-1}$ registered maximum per day productivity (14.13 kg ha$^{-1}$ day$^{-1}$).

## 4.3 Nutrient uptake by blackgram

### 4.3.1 Nitrogen

The data on nitrogen (N) uptake by blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table 18 and depicted in Fig. 6. The blackgram genotype TAU-1 registered significantly

**Table 18. Nutrient uptake (kg $ha^{-1}$) of blackgram genotypes at harvest as influenced by dates of sowing and phosphorus levels**

| Treatments | | Nitrogen uptake (kg/ha) | | | | | Phosphorus uptake (kg/ha) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | P levels (P) | Date of sowing (D) | | | | Mean | Date of sowing (D) | | | | Mean |
| | | $D_1$ | $D_2$ | $D_3$ | **Mean** | | $D_1$ | $D_2$ | $D_3$ | **Mean** | |
| $G_1$ | $P_1$ | 66.93 | 52.85 | 42.81 | **54.20** | **54.47** | 12.60 | 9.37 | 6.17 | **9.39** | **9.44** |
| | $P_2$ | 67.78 | 53.68 | 42.80 | **54.75** | | 12.77 | 9.57 | 6.16 | **9.50** | |
| | **Mean** | **67.35** | **53.27** | **42.81** | | | **12.68** | **9.47** | **6.17** | | |
| $G_2$ | $P_1$ | 60.53 | 51.76 | 40.43 | **50.91** | **51.06** | 11.37 | 7.47 | 5.73 | **8.19** | **8.26** |
| | $P_2$ | 61.16 | 52.20 | 40.29 | **51.22** | | 11.60 | 7.60 | 5.77 | **8.32** | |
| | **Mean** | **60.85** | **51.98** | **40.36** | | | **11.48** | **7.53** | **5.75** | | |
| $G_3$ | $P_1$ | 64.13 | 55.00 | 43.62 | **54.25** | **54.28** | 9.57 | 7.16 | 4.83 | **7.19** | **7.23** |
| | $P_2$ | 64.30 | 55.46 | 43.16 | **54.31** | | 9.76 | 7.27 | 4.76 | **7.27** | |
| | **Mean** | **64.22** | **55.29** | **43.39** | | | **9.67** | **7.22** | **4.80** | | |
| Mean of $P_1$ | | 63.86 | 53.20 | 42.29 | **53.12** | | 11.18 | 8.00 | 5.58 | **8.25** | |
| Mean of $P_2$ | | 64.41 | 53.78 | 42.09 | **53.43** | | 11.49 | 8.14 | 5.78 | **8.47** | |
| **Mean** | | **64.14** | **53.49** | **42.19** | | | **11.29** | **8.07** | **5.57** | | |

| Sources | Nitrogen SEm± | Nitrogen CD (0.05) | Phosphorus SEm± | Phosphorus CD (0.05) |
|---|---|---|---|---|
| Genotype (G) | 0.98 | 2.81 | 0.22 | 0.64 |
| P level (P) | 0.80 | NS | 0.18 | NS |
| Date of sowing (D) | 0.98 | 2.81 | 0.22 | 0.64 |
| G x P | 1.38 | NS | 0.31 | NS |
| G x D | 1.70 | NS | 0.38 | NS |
| P x D | 1.38 | NS | 0.31 | NS |
| G x P x D | 2.40 | NS | 0.54 | NS |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha
NS - Non-significant

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

## Legend

| | | |
|---|---|---|
| I | - | **Genotypes** |
| | $G_1$ - | TAU-1 |
| | $G_2$ - | Manikya |
| | $G_3$ - | K-3 |
| II | - | **Dates of sowing** |
| | $D_1$ - | 16$^{th}$ June |
| | $D_2$ - | 1$^{st}$ July |
| | $D_3$ - | 16$^{th}$ July |
| III | - | **Phosphorus levels** |
| | $P_1$ - | 50 kg $P_2O_5$ $ha^{-1}$ |
| | $P_2$ - | 75 kg $P_2O_5$ $ha^{-1}$ |

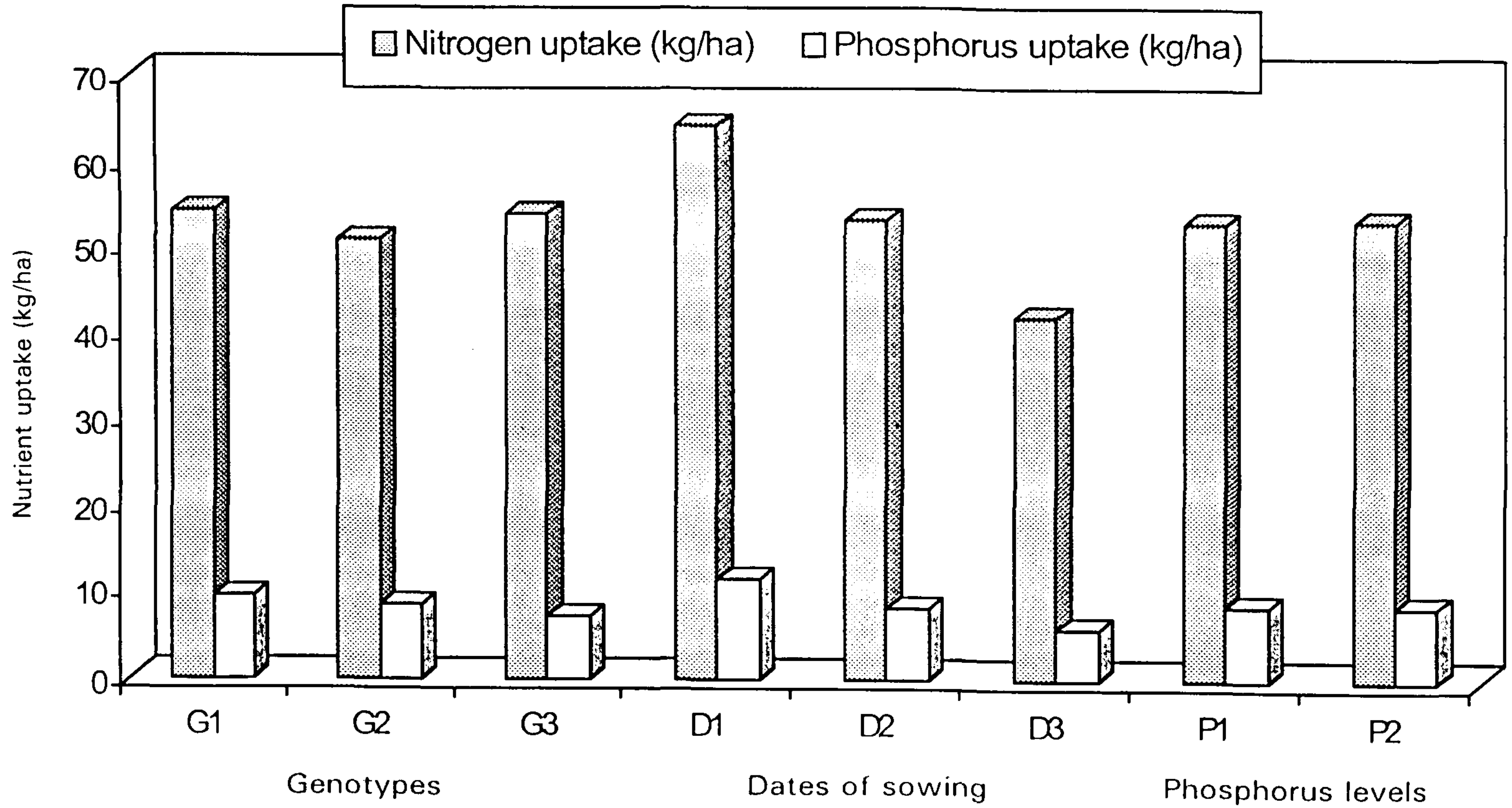


**Fig. 6. Nutrient uptake of blackgram genotypes at harvest as influenced by dates of sowing and phosphorus levels**

higher N uptake (54.47 kg $ha^{-1}$) over Manikya (51.06 kg $ha^{-1}$) and was on par with that of K-3 (54.28 kg $ha^{-1}$).

There was significant difference in N uptake among different dates of sowing. Maximum N uptake was recorded by early sowing on 16th June (64.14 kg $ha^{-1}$) followed by 1st July (53.49 kg $ha^{-1}$) and 16th July (42.19 kg $ha^{-1}$).

No significant difference was observed in nitrogen uptake between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$.

None of the interaction effects were found significant. However, TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$ recorded maximum nitrogen uptake (67.78 kg $ha^{-1}$).

**4.3.2 Phosphorus**

The data on phosphorus uptake by blackgram genotypes as influenced by dates of sowing and phosphorus levels are furnished in Table 18 and depicted in Fig. 6. The genotype TAU-1 recorded significantly higher phosphorus uptake (9.44 kg $ha^{-1}$) compared to Manikya (8.26 kg $ha^{-1}$) and K-3 (7.23 kg $ha^{-1}$).

The crop sown on 16th June registered significantly higher phosphorus uptake (11.29 kg $ha^{-1}$) over 1st July (8.07 kg $ha^{-1}$) and 16th July (5.57 kg $ha^{-1}$).

Application of either 50 kg or 75 kg $P_2O_5$ $ha^{-1}$ had no significant influence on phosphorus uptake by blackgram.

None of the interaction effects were found significant. However, TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$ recorded maximum phosphorus uptake (12.77 kg $ha^{-1}$).

## 4.4 Economics

The data on economics of blackgram genotypes as influenced by dates of sowing and phosphorus levels are presented in Table 19 and depicted in Fig. 7.

Blackgram genotype TAU-1 registered significantly higher gross returns (Rs.22104 $ha^{-1}$) by early sowing on 16th June with 50 kg $P_2O_5$ $ha^{-1}$ over other blackgram genotypes like Manikya and K-3 with varying dates of sowing and phosphorus levels. It was on par with blackgram genotype, TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$.

Significantly higher net returns was realized (Rs.17007 $ha^{-1}$) in blackgram genotype TAU-1 by early sowing on 16th June with 50 kg $P_2O_5$ $ha^{-1}$ over all other treatment combinations. It was on par with genotype TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$.

Significantly higher B:C ratio (3.34) was recorded in blackgram genotype TAU-1 sown on 16th June with 50 kg $P_2O_5$ $ha^{-1}$ over all other treatment combinations except that of TAU-1 sown on 16th June with 75 kg $P_2O_5$ $ha^{-1}$ (2.98). A minimum B:C ratio of 0.47 was obtained in K-3 sown on 16th July with 75 kg $P_2O_5$ $ha^{-1}$.

**Table 19. Economics of blackgram genotypes as influenced by dates of sowing and phosphorus levels**

| Treatment | Gross returns (Rs. ha $^{-1}$) | Cost of cultivation (Rs. ha $^{-1}$) | Net returns (Rs. ha $^{-1}$) | B: C ratio |
|---|---|---|---|---|
| $G_1P_1D_1$ | 22104 | 5096.50 | 17,007 | 3.34 |
| $G_1P_1D_2$ | 14142 | 5096.50 | 9,045 | 1.77 |
| $G_1P_1D_3$ | 10697 | 5096.50 | 5,600 | 1.11 |
| $G_1P_2D_1$ | 22459 | 5646.50 | 16,813 | 2.98 |
| $G_1P_2D_2$ | 15481 | 5646.50 | 9,835 | 1.74 |
| $G_1P_2D_3$ | 10601 | 5646.50 | 4,954 | 0.88 |
| $G_2P_1D_1$ | 19486 | 5256.50 | 14,099 | 2.68 |
| $G_2P_1D_2$ | 13602 | 5256.50 | 8,345 | 1.59 |
| $G_2P_1D_3$ | 9320 | 5256.50 | 4,063 | 0.77 |
| $G_2P_2D_1$ | 19979 | 5806.50 | 14,174 | 2.44 |
| $G_2P_2D_2$ | 14082 | 5806.50 | 8,276 | 1.43 |
| $G_2P_2D_3$ | 9848 | 5806.50 | 4,042 | 0.69 |
| $G_3P_1D_1$ | 17531 | 5096.50 | 12,435 | 2.44 |
| $G_3P_1D_2$ | 13466 | 5096.50 | 8,370 | 1.64 |
| $G_3P_1D_3$ | 8030 | 5096.50 | 2,935 | 0.57 |
| $G_3P_2D_1$ | 19372 | 5646.50 | 13,676 | 2.42 |
| $G_3P_2D_2$ | 14022 | 5646.50 | 8,375 | 1.48 |
| $G_3P_2D_3$ | 8288 | 5646.50 | 2,643 | 0.47 |
| S.Em± | 757 | - | 758 | 0.14 |
| CD (5%) | 2176 | - | 2180 | 0.41 |

$G_1$ - TAU-1
$G_2$ - Manikya
$G_3$ - K-3

$P_1$ - 50 kg $P_2O_5$/ha
$P_2$ - 75 kg $P_2O_5$/ha

$D_1$ - 16th June
$D_2$ - 1st July
$D_3$ - 16th July

Price of blackgram seeds Rs. 1800 q$^{-1}$
Price of blackgram haulm Rs. 500 t$^{-1}$

## Legend

| | | |
|---|---|---|
| $T_1$ | - | TAU-1 sown on 16th June with 50 kg $P_2O_5$/ha |
| $T_2$ | - | TAU-1 sown on 1st July with 50 kg $P_2O_5$/ha |
| $T_3$ | - | TAU-1 sown on 16th July with 50 kg $P_2O_5$/ha |
| $T_4$ | - | TAU-1 sown on 16th June with 75 kg $P_2O_5$/ha |
| $T_5$ | - | TAU-1 sown on 1st July with 75 kg $P_2O_5$/ha |
| $T_6$ | - | TAU-1 sown on 16th July with 75 kg $P_2O_5$/ha |
| $T_7$ | - | Manikya sown on 16th June with 50 kg $P_2O_5$/ha |
| $T_8$ | - | Manikya sown on 1st July with 50 kg $P_2O_5$/ha |
| $T_9$ | - | Manikya sown on 16th July with 50 kg $P_2O_5$/ha |
| $T_{10}$ | - | Manikya sown on 16th June with 75 kg $P_2O_5$/ha |
| $T_{11}$ | - | Manikya sown on 1st July with 75 kg $P_2O_5$/ha |
| $T_{12}$ | - | Manikya sown on 16th July with 75 kg $P_2O_5$/ha |
| $T_{13}$ | - | K-3 sown on 16th June with 50 kg $P_2O_5$/ha |
| $T_{14}$ | - | K-3 sown on 1st July with 50 kg $P_2O_5$/ha |
| $T_{15}$ | - | K-3 sown on 16th July with 50 kg $P_2O_5$/ha |
| $T_{16}$ | - | K-3 sown on 16th June with 75 kg $P_2O_5$/ha |
| $T_{17}$ | - | K-3 sown on 1st July with 75 kg $P_2O_5$/ha |
| $T_{18}$ | - | K-3 sown on 16th July with 75 kg $P_2O_5$/ha |

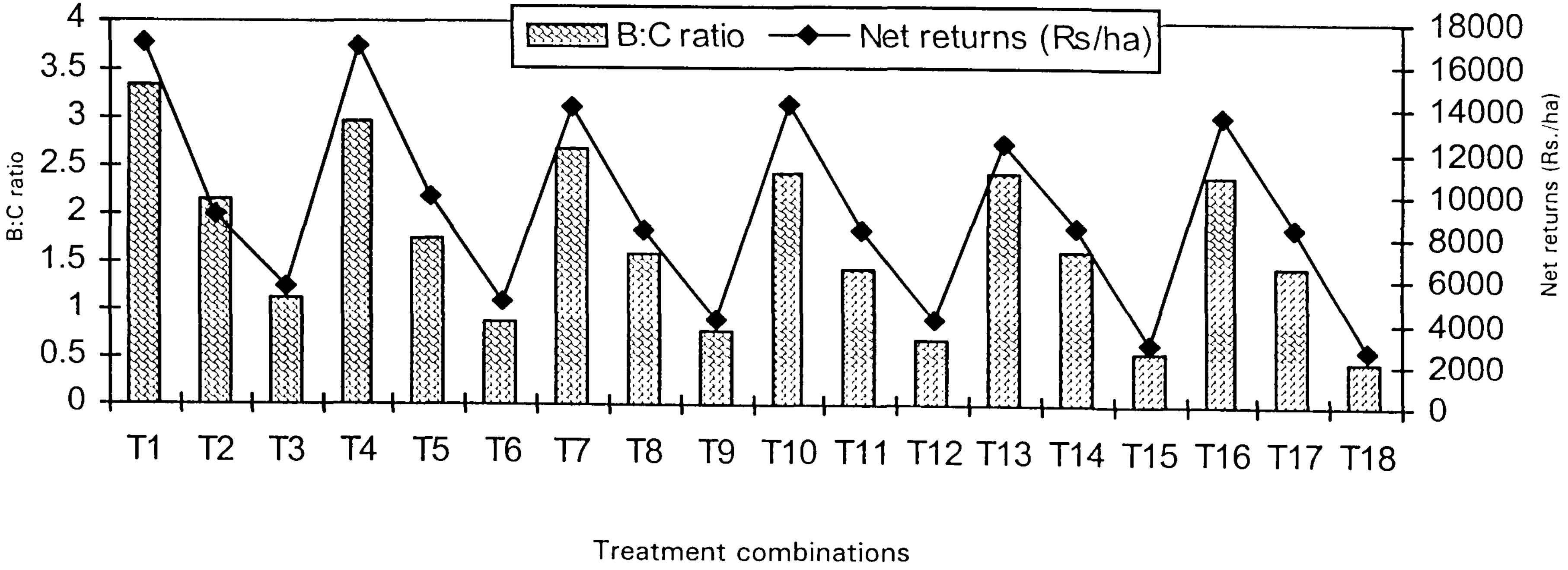


Fig. 7. Economics of blackgram genotypes as influenced by dates of sowing and phosphorus levels

# Discussion

# V. DISCUSSION

The results of the experiment "Response of blackgram genotypes to dates of sowing and phosphorus levels", conducted at Main Research Station, Dharwad during *Kharif* 2001, are discussed in this chapter.

### 5.1 Weather Condition and Crop performance

Crop was raised under transition tract of Dharwad with an annual rainfall of 269.60 mm. The quantity of rainfall received was about 30% of the average annual rainfall. The rainfall received during cropping period from June to October was 194.0 mm. During cropping period the higher monthly rainfall of 58.1 mm and 53.6 mm were received during August and September respectively. The crop sown early on June $16^{th}$ had adequate soil moisture at flowering and pod filling stages followed by crop sown on $1^{st}$ July whereas crop sown late on July $16^{th}$ met with moisture stress at pod filling stage and pest attack. Early sown crop performed better though the annual rainfall was low.

The mean minimum and maximum temperature during cropping period were similar to average temperature of past 51 years. The highest mean maximum temperature of $30.30^{\circ}$ C was observed during June and lowest mean minimum temperature of $20.2^{\circ}$ C was recorded during September.

The relative humidity during cropping period was lower compared to the average relative humidity for the past 51 years. The maximum mean relative humidity of 81per cent was recorded during the months of July and August. The minimum mean relative humidity of 65 per cent was during October.

## 5.2 Performance of blackgram genotypes

Genotypes play an important role in determining yield of a crop. The potential yield of genotypes within its genetic limit is set by its environment. The release of new short duration varieties of pulses is a major breakthrough in achieving higher production. Genotypes differ in their yield potential depending on many physiological processes, which are controlled by both genetic makeup and the environment.

Three genotypes of blackgram (TAU-1, Manikya and K-3) were tried on vertisols under transition tract during *Kharif* 2001. Genotype TAU-1 recorded significantly higher seed yield (845.41 kg $ha^{-1}$) compared to K-3 and Manikya. The increase in seed yield of TAU-1 over Manikya and K-3 was to an extent of 10.39 per cent and 22.39 per cent respectively. Similar better performance of TAU-1 over other genotypes were obtained by Swamy Rao and Konda (1988), Lal Ahmad Mohammad (1998), Anonymous (1994) and Anonymous (2001). The per day productivity was also higher in TAU-1 (9.94 kg) over Manikya and K-3. This is due to higher seed yield of TAU-1 over other genotypes with a maturity period of 85 days. The Harvest index of the TAU-1 (37.12) and Manikya (38.12) were on par and both were significantly higher over K-3 (25.43). Though the haulm yield was maximum in K-3 because of lower harvest index the seed yield was reduced. The results agree with the findings of Mohaptra *et al.* (1996).

The higher seed yield of TAU-1 over other genotypes is attributed to higher values of yield components (number of seeds $pod^{-1}$, seed number $plant^{-1}$, seed weight $plant^{-1}$ and 1000 seed weight). The seed weight $plant^{-1}$ was 3.12 g in TAU-1 when compared to 2.77 g and 2.66 g in Manikya and K-3 respectively. The higher values of the above yield components in TAU-1 was as result of higher values of growth components such as total dry matter production and its dry matter accumulation in reproductive parts compared to other two genotypes. It is always essential for a genotype to produce sufficient dry matter during vegetative phase so as to partition sizable dry matter in reproductive parts to achieve higher yields. The dry matter accumulation in reproductive parts of TAU-1 at harvest was 5.76 g $plant^{-1}$ as against 5.35 and 4.56 g $plant^{-1}$ in Manikya and K-3, respectively. However, the leaf area index of TAU-1 and Manikya were on par during flowering stage. The findings of Swamy Rao and Konda (1988), and Lal Ahmad Mhammad (1998), also support the trend in values of yield components in TAU-1 in comparison with other genotypes.

The higher nitrogen and phosphorus uptake (54.47 kg and 9.44 kg $ha^{-1}$, respectively) were obtained by TAU-1 over Manikya (51.06 kg and 8.26 kg $ha^{-1}$ respectively). Higher nutrient uptake in TAU-1 over Manikya is attributed to higher seed yield. However, the nitrogen uptake by TAU-1 was on par with that of K-3 though the seed yield in K-3 was significantly lower than TAU-1. This is mainly attributed to significantly higher haulm yield (2018.92 kg $ha^{-1}$) in K-3 and lower harvest index (24.43%). Singh and Singh (2000) also reported similar results.

## 5.3 Effect of dates of sowing

Time of sowing plays an important role to fully exploit the genetic potentiality of a variety as it provides optimum growing conditions such as temperature, light, humidity and rainfall. Sowing date determines the time available for vegetative phase before the onset of flowering which is mainly influenced by photoperiod.

Among the agronomic practices of field crops, sowing at optimum time is an important non-cash input that results in considerable increase in the yield under rainfed conditions. This means a favorable soil and climatic conditions are made available for the expression of genetic potential. Blackgram sown early on 16th June recorded maximum seed yield (1068.87 kg $ha^{-1}$) when compared to crop sown on 1st July and 16th July. The crop sown on 16th June registered 117.59 and 44.03 per cent higher yield over crop sown on 16th July and 1st July respectively. The higher seed yield obtained in early sown crop is attributed higher soil moisture during cropping period as a result of receipt of 58.10 mm and 53.60 mm rainfall during August and September respectively. This coincided with the flowering and pod formation stage of early sown crop.

The highest harvest index (38.05%) was also noticed in early sown crop over other dates of sowing, which was mainly due to higher seed yield $ha^{-1}$. This resulted in higher per day productivity (12.47 kg $ha^{-1}$ $day^{-1}$) in early sown crop over the crop late sown. Similar higher seed yields of blackgram from early sown crop from different agro-climatic conditions are reported by several workers (Singh *et al.,* 1968; Bhatnagar *et al.,* 1976; Chaudary *et al.*, 1988; Saharia., 1988; Singh *et al.*, 1999 and Singh and Singh., 2000).

The crop sown early on 16th June got adequate soil moisture particularly during its flowering and pod filling stages in August and September months as a result of higher rainfall (58.1 mm and 53.6 mm respectively). The higher seed yield in early sown crop can also be attributed to higher values of yield components over the late sown crop. There was considerable increase in the values of yield attributing characters (number of pods $plant^{-1}$, seed number $pod^{-1}$, seeds $plant^{-1}$, pod length, seed weight $plant^{-1}$ and 1000 seed weight) in early sown crop compared to crop sown late on 1st July and 16th July.

The seed weight $plant^{-1}$ in early sown crop was 3.48 g as against 2.72 g and 1.85 g in crop sown late on 1st July and 16th July respectively. Similar higher values of yield components in early sown blackgram were also reported by several workers (Singh *et al.*, 1976; Singh *et al.*,1986; Bhatnagar *et al.*, 1976; Chaudary *et al.*, 1988; Saharia, 1988; Jaiswal, 1995; Singh *et al.*, 1999 and Şingh and Singh, 2000).

The values of growth components like leaf area index, total dry matter production $plant^{-1}$ and dry matter accumulation in reproductive parts were also registered in early sown crop which were responsible for higher values of yield components ultimately resulting in increased seed yield $ha^{-1}$. The leaf area index at 60 DAS in early sown crop was 2.40 as against 1.99 and 1.50 in crop sown on 1st July and 16th July respectively. Thus the higher values of LAI in early sown crop resulted in increased production of photosynthates contributing to higher total dry matter production as well as its partitioning to reproductive parts. The total dry matter production at harvest in early sown crop was 10.38 g $plant^{-1}$ as against 9.29 and 8.39 g $plant^{-1}$ in crop sown on 1st July and 16th July respectively. Similarly the dry matter accumulation in reproductive parts of early sown crop at harvest was 5.70 g $plant^{-1}$ as against 5.29 and 4.69 g $plant^{-1}$ in crop sown on 1st July and 16th July respectively. The results agree with the findings of Chaudhary *et al.* (1994), Singh and Singh (2000) and Chaudhary *et al.* (1988). The extent of increase in dry matter accumulation in reproductive parts in early sown crop at 60 DAS and at harvest was 74.73 per cent and 21.54 per cent, respectively over crop sown on 16th July. Higher values of growth components in early sown crop of blackgram were also reported by Singh *et al.* (1986), Srivastava and Verma (1986), Sharia (1988), Gupta and Lal, (1989), Chauadary *et al.* (1994) and Singh and Singh (2000) from different agroclimatic regions of India.

Significantly higher N uptake (64.14 kg $ha^{-1}$) and P uptake (11.29 kg $ha^{-1}$) were obtained by the early sown crop on $16^{th}$ June over $1^{st}$ July and $16^{th}$ July. This is mainly attributed to higher biomass production (seed and haulm yield) by the early sown crop over the crop sown late. The results agree with the findings of Chaudhary *et al.* (1988), Singh and Singh (2000) and Chaudhary *et al.* (1994).

## 5.4 Effect of phosphorus level

Phosphorus a major element in legume nutrition favours healthy root growth by helping in translocation of carbohydrates and promoting seed setting and seed yield. Phosphorus plays a key role in the balanced nutrition of legumes. Phosphorus nutrition is also necessary for the reduction of nitrates and protein formation.

The seed yield of blackgram and nutrient uptake (N and P) were not much influenced by the two phosphorus levels (50 kg and 75 kg $P_2O_5$ $ha^{-1}$) tried. However, the maximum seed yield (784.77 kg $ha^{-1}$) was obtained by the application of 75 kg $P_2O_5$ $ha^{-1}$. The lack of response of blackgram to higher phosphorus level at 75 kg $P_2O_5$ $ha^{-1}$ is attributed to higher available soil phosphorus (32.4 kg $ha^{-1}$). All the values of growth components and yield attributing characters were also on par between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$. Similar results were also reported by several workers (Mishra, 1993; Shah *et al.*, 1994a; Mohapatra *et al.,* 1996; Trivedi, 1996; Ramamoorthy *et al.*, 1997; Singh and Agarwal, 1999; Kishto Kumar *et al.,* 2001; Potluri *et al.*, 1986; Venkateswaralu *et al.*, 1990; Jaggi and Sharma, 1992; Bhalu *et al.,* 1995; Gunjakar *et al.*, 1999; Narendra Singh Thakur, 1999 and Singha and Sarma, 2001).

### 5.5 Interaction effect of genotypes, dates of sowing and phosphorus level

None of the interaction effects involving genotypes, dates of sowing and phosphorus levels were found significant for yield, growth components, yield components and total nutrient uptake of nitrogen and phosphorus of blackgram. However, a maximum seed yield (1201.62 kg $ha^{-1}$) was obtained by TAU-1 sown early on $16^{th}$ June with the application of 75 kg $P_2O_5$ $ha^{-1}$ and the lowest yield (401.28 kg $ha^{-1}$) was recorded by K-3 sown late on July $16^{th}$ with 50 kg $P_2O_5$ $ha^{-1}$. Similar results are also reported by several scientists (Jayanthkumar, 1993; Tomar *et al.*, 1984; Patel *et al.,* 1986; Sharia, 1988 and Kumpawat *et al.*, 1990).

### 5.6 Economics

Net returns were maximum in TAU-1 sown on $16^{th}$ June with 50 kg $P_2O_5$ $ha^{1}$ (Rs.17007 $ha^{-1}$) followed by TAU-1 sown on $16^{th}$ June with 75 kg $P_2O_5$ $ha^{-1}$. This can been attributed to higher blackgram yield these treatment combinations over others. However, a lowest net return was realized by the blackgram genotype K-3 sown on $16^{th}$ July with 75 kg $P_2O_5$ $ha^{-1}$. This is mainly attributed to lower gross returns and higher cost of cultivation in this treatment combination, as a result of considerable reduction in blackgram yield due to moisture stress and pest attack (i.e. pod borer). The results agree with the findigns of Srinivasan *et al.* (1999), Prabhakar Reddy and Narayan Swamy (2000).

Higher benefit cost ratio (3.34) was obtained in the blackgram genotype, TAU-1 sown on $16^{th}$ June with 50 kg $P_2O_5$ $ha^{-1}$. This is mainly due to higher net returns as a result of higher seed yield over other treatment combinations. The minimum B:C ratio (0.47) was obtained in blackgram genotype K-3 sown on 16th July with 75 kg $P_2O_5$ $ha^{-1}$ which was can be attributed to minimum net returns as a result of drastic reduction in blackgram yield and relatively higher cost of cultivation in this treatment combination. The findings of Bhalu *et al.* (1995) and Jaggi and Sharma (1992) also support the data.

## RESULTS OF PRACTICAL UTILITY

1. The blackgram genotype, TAU-1 gave 10.39 per cent and 22.39 per cent higher yield over Manikya and K-3, respectively in vertisols of transition tract of Dharwad.

2. The blackgram sown on 16th June gave 44.03 per cent and 117.59 per cent higher yield over crop sown on 1st July and 16th July respectively.

3. The blackgram genotype TAU-1 sown on 16th June with 50 kg $P_2O_5$ $ha^{-1}$ gave maximum seed yield of blackgram (845.41 kg $ha^{-1}$), net return (Rs.17007 $ha^{-1}$) and higher B:C ratio (3.34), over other treatment combinations.

## FUTURE LINE OF WORK

1. Newly released/releasing and promising genotypes need to be evaluated for their superiority over TAU-1.

2. Performance of blackgram with dates of sowing early to 16th June needs to be evaluated.

3. Phosphorus management with blackgram based cropping systems needs to be studied along with P solubilizers to enhance the phosphorus use efficiency.

# Summary

# VI. SUMMARY

A field experiment entitled "Response of blackgram genotypes to dates of sowing and phosphorus levels" was conducted at Main Research Station, University of Agricultural Sciences, Dharwad during *kharif* 2001. Experiment was laid out in a randomized complete block design with factorial concept. There were 18 treatment combinations consisting of three blackgram genotypes (TAU-1, Manikya and K-3), three dates of sowing (16$^{th}$ June ,1$^{st}$ July and 16$^{th}$ July) and two phosphorus levels(50 kg and 75 kg ha$^{-1}$). Experiment was conducted in black soil with a pH of 7.6 under rainfed condition. The results of the experiment are summarized below.

The blackgram genotype, TAU-1 registered significantly higher seed yield (845.21 kg ha$^{-1}$) over Manikya (765.86 kg ha$^{-1}$) and K-3 (690.77 kg ha$^{-1}$). Maximum seed yield of blackgram was obtained when sown on 16$^{th}$ June (1068.87 kg ha$^{-1}$) followed by 1$^{st}$ July (741.93 kg ha$^{-1}$) and 16$^{th}$ July (491.24 kg ha$^{-1}$). No significant difference was observed in seed yield between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant.

The genotype TAU-1 recorded significantly higher number of seeds plant $^{-1}$ (75.98) compared to Manikya (75.87) and K-3 (67.28). Early sown crop on 16$^{th}$ June registered significantly higher number of seeds plant$^{-1}$ (93.44) over crop sown late on 1$^{st}$ July (71.03) and 16$^{th}$ July (54.64). Application of 50 kg and 75 kg $P_2O_5$ ha$^{-1}$ were statistically on par. The interaction effects on number of seeds plant$^{-1}$ were not significant.

Significantly higher seed weight plant$^{-1}$ and 1000 grain weight (3.12 and 40.18 g, respectively) were obtained in genotype TAU-1 over Manikya

(2.77 and 35.57 g respectively) and K-3 (2.66 and 39.91 g respectively). The blackgram sown on 16th June registered significantly higher seed weight plant$^{-1}$ and 1000 seed weight (3.48 and 43.13 g, respectively) compared to 1st July (2.72 and 38.58 g respectively) and 16th July (1.85 and 33.94 g respectively). Application of 50 kg and 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on seed weight plant$^{-1}$ and 100 grain weight. None of the interaction effects were found significant.

The blackgram genotype, K-3 recorded significantly higher leaf area index at 30 and 60 DAS (0.46 and 2.47, respectively) over Manikya (0.31 and 1.48, respectively) and TAU-1 (0.37 and 1.95, respectively). Blackgram sown on 16th June registered significantly higher leaf area index at 30 and 60 DAS (0.48 and 2.40, respectively) than 1st July (0.38 and 1.99, respectively) and 16th July (0.29 and 1.50, respectively). No significant difference was observed in leaf area index between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. The interaction effects were not significant.

The blackgram genotype, K-3 recorded significantly higher total dry matter production at 30 DAS, 60 DAS and at harvest (1.06, 9.18 and 10.27 g plant$^{-1}$, respectively) over TAU-1 and Manikya. Blackgram sown on 16th June similarly registered significantly higher total dry matter production (1.09, 9.14 and 10.38 g plant$^{-1}$) over 1st July and 16th July. No significant difference was observed in total dry matter production of blackgram between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of the interaction effects were found significant.

Significantly higher dry matter accumulation in pods were obtained by TAU-1 at 60 DAS and harvest (2.47 and 5.76 g plant$^{-1}$) over Manikya and K-3. Blackgram sown on 16th June produced significantly higher dry matter accumulation in pods at 60 DAS and at harvest (2.26 g and 5.70 g plant$^{-1}$, respectively) over 1$^{st}$ July and 16$^{th}$ July. Application of 50 kg and 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on dry matter accumulation in pods. The interaction effects were not significant.

Significantly higher nitrogen uptake was found in TAU-1 (54.47 kg ha$^{-1}$) over Manikya (51.06 kg ha$^{-1}$) and was on par with that of K-3 (54.28 kg ha$^{-1}$). Early sowing of blackgram on 16$^{th}$ June recorded significantly higher nitrogen uptake (64.14 kg ha$^{-1}$) over 1$^{st}$ July (53.49) and 16$^{th}$ July (42.19 kg ha$^{-1}$). No significant difference was observed in nitrogen uptake between 50 kg and 75 kg $P_2O_5$ ha$^{-1}$. None of interaction effects were found significant.

The blackgram genotype, TAU-1 recorded significantly higher phosphorus uptake (9.44 kg ha$^{-1}$) over Manikya (8.26 kg ha$^{-1}$) and K-3 (7.23 kg ha$^{-1}$). Among the dates of sowing, blackgram sown on 16$^{th}$ June recorded significantly higher phosphorus uptake (11.29 kg ha$^{-1}$) over 1$^{st}$ July (8.07 kg ha$^{-1}$) and 16$^{th}$ July (5.57 kg ha$^{-1}$). Application of 50 kg and 75 kg $P_2O_5$ ha$^{-1}$ had no significant influence on phosphorus uptake. None of the interaction effects were found significant.

Significantly higher net returns and B:C ratio were realized (Rs.17,007 ha$^{-1}$ and 3.34 respectively) in blackgram genotype TAU-1 sown early on 16$^{th}$ June with 50 kg $P_2O_5$ ha$^{-1}$ over all other treatment combinations. It was on par with genotype TAU-1 sown on 16$^{th}$ June with 75 kg $P_2O_5$ ha$^{-1}$ (Rs.16,813 ha$^{-1}$and 2.98, respectively).

# References

# VII. REFERENCES


ABDUL SALAM, M. AND VIKRAMAN NAIR, R., 1982, Note on the effect of graded doses of lime and phosphorus on the growth, yield and quality of urdbean (*Vigna mungo)* in the sandy clay loam soil of Kerala. *Legume Research*, **5**: 115-118.

ANONYMOUS, 1994, *Annual Progress Report.* Agricultural Research Station, Bheemarayanagudi, University of Agricultural Sciences, Dharwad.

ANONYMOUS, 2000, Food and Agriculture. *Quarterly Bulletin Statistics*, Organisation of United Nations, Rome.

ANONYMOUS, 2001, *Annual Report for 2000-01.* Southern Transitional Zone (Zone-VII), University of Agricultural Sciences, Bangalore.

ASTHANA, A. N., 1998, Pulse crops research in India. *The Indian Journal of Agricultural Sciences*, **68**: 448-452.

BHALU, V. B., SADARIA, S. G., KANERIA, B. B. AND KHANPARA, V. D., 1995, Effect of nitrogen, phosphorus and *Rhizobium* inoculation on yield and quality, N and P uptake and economics of blackgram (*Phaseolus mungo*). *Indian Journal of Agronomy*, **40**: 316-318.

BHATNAGAR, O. K., GUPTA, N. K. AND TRIVEDI, U. S., 1976, Effect of sowing dates on the grain yield of urd in central Uttar Pradesh. *Indian Journal of Agronomy*, **21**: 80.

CHAKOR, L. S. AND RANA, K. S., 1992, Effect of irrigation and sowing dates on yield of spring planted blackgram (*Phaseolus mungo*), kidney bean (*P. vulgaris*) and greengram (*P. radiatus*). *Indian Journal of Agronomy*, **37**: 590-591.

CHAUDHARY, D. C., SINGH, R. P. AND SINGH, N. P., 1988, Response of blackgram cultivars to dates of planting. *Indian Journal of Agronomy*, **33**: 442-445.

CHAUDHARY, D. C., SINGH, R. P. AND SINGH, N. P., 1994, Growth behaviour of urdbean varieties in relation to planting dates. *Legume Research,* **17**: 124-126.

DASTANE, N. G., 1967, *A Practical Manual for Water Use Research,* Navbharat Prakashan Publication, Poona.

DONALD, C.M., 1962, Competition among crop and pasture plants. *Advances in Agronomy,* **15**: 1-118.

EBERHORT, S. A. AND RUSSEL, W. A., 1966, Stability parameters for comparing varieties. *Crop Science,* **6**: 36-40.

GOMEZ, K. A. AND GOMEZ, A. A., 1984, *Statistical Procedures for Agricultural Research.* Edition 2, John Willey, New York, p. 693.

GUNJKAR, M. U., DHOBLE, M. V., DAHIPHALE, V. V. AND JADHAV, A. S., 1999, Response of blackgram (var. TAU-1) to nitrogen and phosphorus fertilization. *Journal of Maharashtra Agricultural Universities,* **24**: 211.

GUPTA, A. AND LAL, S. S., 1989, Response of summer blackgram to date of sowing and seed rate. *Indian Journal of Agronomy,* **34**: 197-199.

JACKSON, M. L., 1973, *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd., New Delhi, pp. 183-192.

JAGGI, R. G. AND SHARMA, C. M., 1992, Effect of phosphorus and sulphur on blackgram (*Phaseolus mungo*) yield and nutrient uptake in an acid hill soil. *Indian Journal of Agronomy,* **37**: 261-264.

JAISWAL, V. P., 1995, Performance of greengram (*Phaseolus radiatus*) and blackgram (*Phaseolus mungo*) genotypes to dates of sowing during *summer. Indian Journal of Agronomy,* **40**: 516-518.

JAMWAL, J. S., KALYAN SINGH AND RAO, K. L., 1990, Dry matter accumulation, protein content and nutrient uptake of blackgram as influenced by phosphorus and bio-fertilizers. *The Andhra Agricultural Journal,* **37**: 288-291.

JAMWAL, J. S., KALYAN SINGH, SINGH, T. K. AND SINGH, J. P., 1989, Effect of phosphorus and biofertilizers on yield and quality of blackgram (*Vigna mungo* (L.) Hepper). *Annals of Agricultural Research*, **10**: 249-252.

JAYANTHKUMAR, D.,1993, Response of soybean (*Glycine max* (L). Merrill) to phosphorus nutrition on alfisols under irrigated conditions. *M. Sc. (Agri) Thesis*, University of Agricultural Sciences, Bangalore.

JAYAPAUL, P. AND GENESARAJA, V., 1990, Studies on response of soybean cultivars to nitrogen and phosphorus. *Indian Journal of Agronomy*, **35**: 329-330.

KHANDKAR, U. R. AND SHINDE, D. A., 1991, Phosphorus nutrition of blackgram as influenced by P and S application. *Journal of Indian Society of Soil Sciences*, **39**: 583-585.

KISHTO KUMAR, VERMA, A. K. AND SRIVASTAVA, G. P., 2000, Yield attributing character and grain yield of urdbean (*Vigna mungo* L. Hepper) as influenced by levels of phosphatic application. *Journal of Research* (Birsa Agricultural University), **12**: 233-234.

KISHTO KUMAR, VERMA, A. K. AND SRIVASTAVA, G. P., 2001, Growth parameters and rooting pattern of urdbean (*Vigna mungo* (L.) Hepper) as influenced by levels of phosphate. *Journal of Research* (Birsa Agricultural University), **13**: 205-207.

KUMPAWAT, B. S., SINGH, R. P. AND RATHORE, S. S., 1990, Response of chickpea cultivars to phosphorus. *Indian Journal of Agronomy*, **35**: 416-417.

LAL AHMED MOHAMMAD, 1998, Stability of morpho-physiological traits influencing seed yield in blackgram (*Vigna mungo* L. Hepper). *M. Sc. (Agri) Thesis*, University of Agricultural Sciences, Dharwad.

MOHAPATRA, S. C., PATRA, A. K., SENAPATI, S. C. AND MISHRA, A., 1996, Response of blackgram (*Phaseolus mungo* L.) varieties to phosphorus. *Crop Research*,**11**: 165-168.

MISHRA, C. M., 1993, Response of blackgram (*Phaseolus mungo*) varieties to levels of phosphorus under rainfed conditions. *Indian Journal of Agronomy*, **38**: 489-490.

NARENDRA SINGH THAKUR, 1999, Effect of phosphorus and sulphur levels with and without rhizobium inoculation on growth and yield of blackgram (*Vigna mungo* L.). *Advances in Agricultural Research in India*, **13**: 66-70.

PAIKERA, A., MISHRA, M. AND MISHRA, S. N., 1988, Response of soybean varieties to nitrogen and phosphorus. *Indian Journal of Agronomy*, **33**: 320-322.

PATEL, M. P., DUNGARANI, R. A., PATEL, H. C., PATEL, R. G. AND PATEL, R. B., 1986, Response of groundnut cultivars to different dates of sowing under rainfed conditions. *Indian Journal of Agronomy*, **31**: 285-288.

PATRA, A. K., KARMAKAR, S. K. AND MUKHERJEE, S. K., 2001, Response of blackgram (*Phaseolus mungo* L.) varieties to dates of sowing during winter. *The Indian Journal of Agricultural Sciences*, **71**: 405-407.

PIPER, C. S., 1966, *Soil and Plant Analysis*. Academic Press, New York, pp. 47-77.

POTLURI, P. P., PACHECO, T. G., RAJU, A. S. AND RAO, M. S., 1986, Effect of soil moisture regimes on yield and phosphorus nutrition of blackgram (*Vigna mungo* (L.) Wilczek) at different levels of applied phosphorus. *The Andhra Agricultural Journal*, **33**: 12-15.

PRABHAKAR REDDY, B. AND NARAYANA SWAMY, S., 2000, Effect of farm yard manure, phosphate solubilizing bacteria and phosphorus on yield and economics of blackgram (*Phaseolus mungo* L.). *The Indian Journal of Agricultural Sciences*, **70**: 694-696.

RAMAMOORTHY, K., BALASUBRAMANIAN, A. AND AROKIARAI, A., 1997, Response of rainfed blackgram (*Phaseolus mungo*) to phosphorus and sulphur nutrition in red lateritic soils. *Indian Journal of Agronomy*, **42**: 191-193.

SAHARIA, P., 1986, Relative performance of pea varieties to dates of sowing. *Indian Journal of Agronomy*, **31**: 377-379.

SAHARIA, P., 1988, Response of blackgram varieties to sowing dates and row spacing. *Indian Journal of Agronomy*, **33**: 261-264.

SEKHON, H. S., GILL, A. S., GURIQBAL, SINGH AND DEVINDER SINGH, 1993, Effect of date of sowing and seed rate on summer blackgram (*Phaseolus mungo*). *Indian Journal of Agronomy*, **38**: 315-316.

SESTAK, Z., CASTKY, J. AND JARRIS, P. G., 1971, Plant analysis in production manual for methods. Ed. Junk, W., N. V. N. V. Publications, *The Hague*, pp. 343-381.

SHAH, S. K., SHARMA, G. L. AND VYAS, A. K., 1994a, Growth parameters, biomass production and nutrient uptake by blackgram (*Phaseolus mungo*) as influenced by phosphorus, potassium and plant growth regulator. *Indian Journal of Agronomy*, **39**: 481-483.

SHAH, S. K., SHARMA, G. L. AND VYAS, A. K., 1994b, Effect of phosphorus, potassium and plant growth regulators on yield and quality of blackgram. *Annals of Agricultural Research*, **15**: 362-364.

SHARD, K., BISHNOI, S. K. AND AZAD, A. S., 1991, Effect of lime and phosphate on the yield and protein content by blackgram. *Journal of Indian Society of Soil Sciences*, **39**: 593-594.

SINGH, A., AHLAWAT, I. P. S. AND SARAF, C. S., 1976, Response of blackgram to sowing dates and row spacings. *Indian Journal of Agronomy*, 21(2): 139-140.

SINGH, D. K. AND SINGH, V. K., 2000, Growth and nitrogen uptake pattern of promising urdbean genotypes under different sowing dates and plant densities during rainy season. *Annals of Agricultural Research*, **21**: 456-458.

SINGH, R. C., MEHAR SINGH, DAHIYA, D. R. AND PHOGAT, S. B., 1986, Effect of dates of sowing and seed rates on summer season urdbean. *Indian Journal of Agronomy*, **31**: 187-188.

SINGH, V. K., SINGH, N. P., SHARMA, B. B. AND SAHU, J. P., 1999, Effect of non-monetary inputs on sustained productivity of urdbean (*Phaseolus mungo*). *Indian Journal of Agronomy*, **44**: 773-777.

SINGH, Y. P. AND AGARWAL, R. L., 1999, Effect of levels of sulphur and phosphorus on yield and quality of blackgram (*Vigna mungo* L. Hepper). *Indian Journal of Soil Conservation*, **27**: 261-262.

SINGHA, D. D. AND SARMA, A., 2001, Response of blackgram (*Phaseolus mungo*) to phosphorus fertilization and rhizobium inoculation in the hilly soils of Assam. *Annals of Agricultural Research*, **22**: 151-153.

SRINIVASAN, K., RAMASAMY, M. AND SANKARAN, 1999, Effect of phosphorus and sulphur nutrition on growth and yield of blackgram. *Madras Agricultural Journal*, **86**: 539-540.

SRIVASTAVA, G. P. AND VERMA, U. K., 1986, Effect of dates of sowing on grain yield of blackgram (*Vigna mungo*). *Indian Journal of Agronomy*, **31**: 294-295.

SUBBA RAO, D. V., REDDY, P. J. R., RAMA RAO, G. AND MAHALAKSHMI, B. K., 1999, Performance of blackgram cultivars at different seed rate during rabi. *The Andhra Agricultural Journal*, **46**: 286-288.

SUBBAIAH, B. V. AND ASIJA, G. L., 1959, A rapid procedure for estimation of available nitrogen in soils. *Current Science*, **25**: 259-260.

SURYA KUMARI, Y., NAIDU, T. C. M. AND HANUMANTHA RAO, 2000, Performance of blackgram genotypes under receding soil moisture conditions. *The Andhra Agricultural Journal*, **47**: 98-102.

SWAMINATHAN, M. S. AND JAIN, H. K., 1973, Food legume in Indian Agriculture. In: *Nutritional Improvement of Food Legumes by Breeding*, Ed. Milner, M., PAG (UN), New York, pp. 69-82.

SWAMY RAO, T. AND KONDA, C. R., 1988, New and improved high yielding varieties in some pulse crops. *Training Programme on Pulse Production Technology* from September 28-30. Eds. M. M. Hosmani and B. M. Chittapur, Department of Agronomy, University of Agricultural Sciences, Dharwad.

TOMAR, S. S., SHARMA, R. K. AND NAMDEO, K. N., 1984, Performance of urdbean (*Vigna mungo*) varieties under various row spacings and fertility levels. *Legume Research*, **7**: 51-53.

TOMAR, S. S. AND TIWARI, A. S., 1991, Effect of plant density on genotypes of greengram (*Phaseolus radiatus*) and blackgram (*Phaseolus mungo*). *The Indian Journal of Agricultural Sciences*, **61**: 126-127.

TRIVEDI, S. K.,1996, Response of blackgram (*Phaseolus mungo*) to nitrogen, phosphorus and sulphur. *Legume Research*,**19**: 7-9.

TRIVEDI, S. K., VIJAY SINGH AND SHINDE, C. P., 1997, Effect of nitrogen, phosphorus and sulphur on yield and chemical composition of blackgram (*Phaseolus mungo*). *Gujarath Agricultural University Research Journal*, **22**: 46-50.

VAIRAVI, K., RAMASWAMY, M. AND SRINIVAS, K., 1997, Performance of blackgram genotypes under red lateritic soil. *Madras Agricultural Journal*, **84**: 109-110.

VENKATESWARLU, V., RAO, V. V., RAO, A. S. AND KOTESWARA RAO, D. S., 1990, Effect of methods of weed control and phosphorus levels on blackgram (*Vigna mungo*). *The Andra Agricultural Journal*, **37**: 97-99.

VIVEKANANDAN, A. S., GUNASENA, H. P. M. AND SHIVANAYAGAN, T., 1972, Statistical evaluation of the accuracy of three techniques used in the estimation of leaf area of crop plants. *The Indian Journal of Agricultural Sciences*, **42**: 857-860.

VYAS, M. D., SONI, J. C., RAJPUT, O. P., THAKRE, D. I., SINGH, P. P., KALYAN, P. AND KALYAN SINGH, 1987, Response of soybean to phosphorus application. *Indian Journal of Agronomy*, **32**: 198.

# Appendices

**Appendix I. Weekly meteorological data for the cropping period at Main Research Station, University of Agricultural Sciences, Dharwad.**

| Months | Temperature (°C) | | Relative humidity (%) | | Rainfall (mm) | No. of rain days |
|---|---|---|---|---|---|---|
| | Maximum | Minimum | Max | Min | | |
| 11 June to 17 June | 28.30 | 20.20 | 86.50 | 73.50 | 27.50 | 4 |
| 18 June to 24 June | 29.00 | 21.60 | 84.50 | 69.40 | 0.80 | 0 |
| 25 June to 01 July | 29.20 | 21.50 | 85.00 | 69.50 | 0.70 | 0 |
| 02 July to 08 July | 30.40 | 21.20 | 93.40 | 78.40 | 10.90 | 2 |
| 09 July to 15 July | 25.80 | 20.90 | 89.60 | 81.00 | 13.00 | 2 |
| 16 July to 22 July | 27.10 | 20.90 | 87.80 | 74.10 | 2.00 | 0 |
| 23 July to 29 July | 27.10 | 21.40 | 86.60 | 76.90 | 7.20 | 1 |
| 30 July to 05 August | 27.60 | 21.00 | 82.30 | 76.90 | 34.80 | 2 |
| 06 August to 12August | 27.40 | 21.30 | 87.30 | 71.90 | 0.60 | 0 |
| 13 August to 19August | 26.20 | 20.90 | 90.70 | 78.90 | 14.00 | 3 |
| 20 August to 26August | 26.20 | 20.60 | 89.00 | 74.90 | 4.30 | 0 |
| 27 August to 02 September | 28.70 | 20.40 | 84.40 | 65.10 | 4.40 | 0 |
| 03 September to 09 September | 29.90 | 25.60 | 80.30 | 62.40 | 0.00 | 0 |
| 10 September to 16 September | 31.10 | 19.90 | 80.60 | 56.60 | 0.00 | 0 |
| 17 September to 23 September | 30.20 | 20.80 | 88.70 | 56.10 | 33.30 | 3 |
| 24 September to 30 September | 29.70 | 29.70 | 85.00 | 63.30 | 20.30 | 2 |
| 01 October to 07 October | 29.30 | 29.30 | 86.00 | 66.30 | 4.50 | 1 |
| 08 October to 14 October | 29.10 | 29.10 | 88.90 | 64.30 | 3.50 | 1 |
| 15 October to 21 October | 29.40 | 29.40 | 84.70 | 67.80 | 9.00 | 1 |
| Total | | | | | 190.8 | 22 |

**Appendix II. Details of cost of inputs used and price of outputs**

| | Item | Quantity ($ha^{-1}$) | Rate (Rs.) |
|---|---|---|---|
| **I.** | **Inputs** | | |
| 1. | Seed | | |
| | TAU-1 | 20 kg | 32 $kg^{-1}$ |
| | Manikya | 25 kg | 32 $kg^{-1}$ |
| | K-3 | 20 kg | 32 $kg^{-1}$ |
| **2.** | **Fertilizers** | | |
| | Urea | 25 kg N | 10.71 $kg^{-1}$ |
| | SSP | 50 kg $P_2O_5$ | 22 $kg^{-1}$ |
| | | 75 kg $P_2O_5$ | 22 $kg^{-1}$ |
| **3.** | **Rhizobium** | 375 g | 18.75 |
| **4.** | **Plant protection** | | |
| | Endosulfan | 1 litre | 220 $l^{-1}$ |
| | Monocrotophos | 1 litre | 290 $l^{-1}$ |
| **4** | **Labour wages** | - | 35 $day^{-1}$ |
| **5.** | **Bullock pair** | - | 180 $day^{-1}$ |
| **II.** | **Outputs** | | |
| | Blackgram seeds | - | 1800 $q^{-1}$ |
| | Blackgram haulm | - | 500 $t^{-1}$ |

**Appendix III. Harvesting dates of different blackgram genotypes**

| Sl. No. | Date of sowing | Genotypes | | |
|---|---|---|---|---|
| | | TAU-1 | Manikya | K-3 |
| 1. | 16th June | 10-09-2001 | 01-09-2001 | 17-09-2001 |
| 2. | 1st July | 26-09-2001 | 17-09-2001 | 01-10-2001 |
| 3. | 16th July | 10-10-2001 | 01-10-2001 | 16-10-2001 |

# RESPONSE OF BLACKGRAM (*Vigna mungo* L.) GENOTYPES TO DATES OF SOWING AND PHOSPHORUS LEVELS IN NORTHERN TRANSITIONAL TRACT OF KARNATAKA

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## ABSTRACT

A field experiment entitled "Response of blackgram genotypes to dates of sowing and phosphorus levels" was conducted at Main Research Station, University of Agricultural Sciences, Dharwad during *kharif,* 2001. Experiment was laid out in a randomized complete block design with factorial concept. There were 18 treatment combinations consisting of three blackgram genotypes (TAU-1, Manikya and K-3), three dates of sowing ($16^{th}$ June ,$1^{st}$ July and $16^{th}$ July) and two phosphorus levels(50 kg and 75 kg $P_2O_5$ $ha^{-1}$). Experiment was conducted in medium black soil with a pH of 7.6 under rainfed condition.

The blackgram genotype, TAU-1 registered significantly higher seed yield (845.21 kg $ha^{-1}$) over Manikya (765.86 kg $ha^{-1}$) and K-3 (690.77 kg $ha^{-1}$). Maximum seed yield of blackgram was obtained when sown on $16^{th}$ June (1068.87 kg $ha^{-1}$) followed by $1^{st}$ July (741.93 kg $ha^{-1}$) and $16^{th}$ July (491.24 kg $ha^{-1}$). No significant difference was observed in seed yield between 50 kg and 75 kg $P_2O_5$ $ha^{-1}$. None of the interaction effects were found significant.

Blackgram genotype, TAU-1 recorded higher N and P uptake (54.47 and 9.44 kg $ha^{-1}$, respectively) over Manikya and K-3. The crop sown on $16^{th}$ June registered significantly higher N and P uptake (64.14 kg $ha^{-1}$ and 11.29 kg $ha^{-1}$) compared to other sowing dates. No significant difference was observed in N and P uptake between 50 kg or 75 kg $P_2O_5$ $ha^{-1}$. All the interaction effects were not found significant.

Blackgram genotype, TAU-1 sown early on $16^{th}$ June with 50 kg $P_2O_5$ $ha^{-1}$ recorded maximum net returns of Rs.17,007 $ha^{-1}$ and B:C ratio of 3.34.