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# Effect of different dates of sowing, varieties and their interactions on grain yield and yield components (*Vigna radiate* L.) in rainfed situation under southern transitional Zone of Karnataka

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## Abstract
A field experiment was conducted at Agronomy Field unit, College of Agriculture, Shivamogga during *kharif* 2015-2016 and 2016-17 on sandy loamy soils to evaluate performance of promising Greengram varieties (*Vigna radiate* (L.) Wilczek) as influenced by different dates of sowing under *rain fed* situation in Southern Transitional Zone of Karnataka. Among three different varieties KKM-3 gave significantly higher grain yield (806.41 kg $ha^{-1}$) and haulm yield (3206.14 kg $ha^{-1}$) than PDM 84-178 (675.71 kg $ha^{-1}$ and 2698.55 kg $ha^{-1}$, respectively) and SBM-1 (610.81 kg $ha^{-1}$ and 2462.74 kg $ha^{-1}$, respectively) (Table 1). Variety KKM-3 showed per cent increase in grain and straw yield over variety PDM 84-178 (16.20% and 15.83%, respectively) and SBM-1 (24.25% and 23.18%, respectively). Among different dates of sowing $15^{th}$ July recorded significantly higher grain and straw yield (1252.86 kg $ha^{-1}$ and 4912.04 kg $ha^{-1}$, respectively) followed by sowing KKM-3 on $30^{th}$ of July (878.82 kg $ha^{-1}$ and 3344.05 kg $ha^{-1}$, respectively) and it was found on par with PDM 84-178 sown on $15^{th}$ of July (869.92 kg $ha^{-1}$and 3405.49 kg $ha^{-1}$, respectively) compared to variety SBM-1 on $15^{th}$ July (774.98 kg $ha^{-1}$ and 3033.19 kg $ha^{-1}$, respectively) Among the interactions significant difference was noticed between date of sowing and variety with respect to yield components, sowing of variety KKM-3 sown on July $15^{th}$ recorded significantly higher number of clusters $plant^{-1}$, numbers of pods plant, numbers of seeds per pod (13.59, 53.03 and 11.10, respectively) compared to late sowing variety PDM 84-178 during August $30^{th}$ (6.96, 31.31 and 8.56, respectively) and late sowing variety SBM-1 on August $30^{th}$ (4.75, 17.57 and 8.03, respectively).

**Keywords:** Greengram, KKM-3, PDM 84 -178, SBM-1

## Introduction
Green gram locally called as moong or mung [*Vigna radiata* (L.) Wilczek] belong to the family Leguminoceae**.** It is an ancient and well-known pulse crop that belongs to family *leguminosae* and originated from South East Asia (Mogotsi, 2006) [10]. Pulses are the important sources of proteins, vitamins and minerals for the predominantly vegetarian population and are popularly known as "Poor man's meat" and "rich man's vegetable" (Singh and Singh, 1992) [18]. The important green gram growing states are Rajasthan, Madhya Pradesh, Uttar Pradesh, Odisha, Maharashtra, Karnataka and Bihar. In Karnataka, it occupies 421.04 ha area with a production of 142.57 tonnes with the productivity of 330 kg $ha^{-1}$ (Anon, 2019) [1]. The impending crisis in greengram for India's growing population is obvious. Varieties play an important role in crop production and the potential yield of a variety within the genetic limit as determined by its environment. Hence, combination of genotype and environmental factor can bring about increase in production. Difference in yield of genotypes is attributed to the complex process occurring in various parts of the plant involving many physiological changes. These physiological changes are influenced by environmental factors prevailing at different stages of crop growth. To understand yield variation among greengram varieties in different environments, agronomic practices and yield analysis are required.
The release of high yielding varieties has contributed a great deal towards the improvement of greengram yields. Many improved varieties *viz*., KKM-3, Pusa Baisaki, PS-16, TAP-7, BGS-9, DGGV-2 and Chaina Mung has been developed and released for general cultivations in Karnataka, the yield potential of these high yielding varieties can be further exploited through

better agronomic practices. The gap between potential and existing yield of greengram can be bridged by using optimized spacing of various greengram varieties to improve its production by achieving optimum plant population (Sathyamoorthi *et al.*, 2012) [16]. Among the various agronomic practices, planting time is the most important factor influencing the yield of greengram. Planting time of green gram differs from one production region to another and also from variety to variety. The optimum time of sowing ensures the complete harmony between the vegetative and reproductive phases on one hand, and the climatic rhythm on the other and helps in realizing the potential yield. (Venkateswarulu and Rajan, 1991) [20].

However, information about response of newly developed greengram varieties to different dates of sowing in Southern Transitional Zone of Karnataka. In the present investigation attempts have been made to identify the suitable variety with suitable time of sowing

**Experimental Site:** A field study was carried out during *Kharif* seasons of agricultural year 2015 and 2016 at College of Agriculture, University of Agricultural and Horticultural Sciences (UAHS), Navile, Shivamogga. The experimental field soil was red sandy loam in texture with lower level organic carbon (0.49%) and available nitrogen (240 kg $ha^{-1}$), higher level of available phosphorus (79.25 kg $ha^{-1}$) and medium level of available potassium (139.23 kg $ha^{-1}$). The area receives an total of 1232.80 mm and 574.40 mm rainfall was received during 2015 and 2016 respectively, as against the normal of 883.30 mm. Rainfall received during 2015 was 349.50 mm in excess whereas, during 2016 the rainfall received was deficit by 308.9 mm over the normal.

**Treatments:** The treatments included in the experiment were $T_1$: KKM-3 sowing on July 15$^{th}$, $T_2$: KKM-3 sowing on July 30$^{th}$, $T_3$: KKM-3 sowing on August 15$^{th}$, $T_4$: KKM-3 sowing on August 30$^{th}$, $T_5$: PDM 84-178 sowing on July 15$^{th}$, $T_6$: PDM 84-178 sowing on July 30$^{th}$, $T_7$: PDM 84-178 sowing on August 15$^{th}$, $T_8$: PDM 84-178 sowing on August 30$^{th}$, $T_9$: SBM-1 sowing on July 15$^{th}$, $T_{10}$: SBM-1 sowing on July 30$^{th}$, $T_{11}$: SBM-1 sowing on August 15$^{th}$, $T_{12}$: SBM-1 sowing on August 30$^{th}$. The experiment was laid out in randomized block design with factorial concept replicated in to three times.

## Results and Discussion

Greengram yields lower at farmers field due to less awareness about optimum date of sowing and lack of knowledge about varieties as such sowing time is a nonmonitory input and is the single most important factor to achieved optimum yields (Malik *et al.* 2003) [9]. Optimum sowing time also vary from season to season due to variation in agro ecological conditions (Sarkar *et al.* 2004) [15]. The time of sowing is the most important agronomic factor for realizing the yield potential of improved varieties, helps in achieving complete harmony between vegetative and reproductive stages of the crop. Therefore sowing of the crop at optimum time plays a key role in obtaining the high seed yields (Rathore *et al.,* 2010) [13].

Delayed sowing usually reduce yield and increases cost of cultivation. Usually Mid-June to mid July is found optimum time for *kharif* season (Jiotide, 2017) [7]. While further late sowing fetches lesser grain yield due to short growing season and ultimately lesser accumulation of photosynthates (Fraz *et al.*, 2006) [6]. Optimum time of sowing ensures better harmony between the plant and weather which ultimately results in higher seed yield. Growth behavior of greengram is unique due to large variations among varieties with respect to growth habit, maturity duration, seed colour and seed size and yield performance (Dodwadiya and Sharma, 2012) [5]. Therefore, there must be a specific sowing dates, especially in *Kharif* season with selection of suitable varieties that is necessary to obtain maximum yield at lower of cost of cultivation.

Sowing dates had significant effect on greengram yield and yield attributes during the study periods of 2015 and 2016. The yields of greengram in the two growing seasons are presented in Table 1 and 2. Among four dates of sowing evaluated for their performance, crop sown on July 15$^{th}$ recorded significantly higher grain and haulm yield (965.92 and 3783.57 kg $ha^{-1}$, respectively). This was followed by July 30$^{th}$ grain and haulm yield (774.60 and 2999.64 kg $ha^{-1}$, respectively) as compared to August 15$^{th}$ (567.44 and 2293.51 $ha^{-1}$, respectively) and August 30$^{th}$ (482.61 and 1920.22 kg $ha^{-1}$, respectively) (Table.1). Delayed sowing beyond June 15$^{th}$ resulted in decrease in yield at the rate of 484.31 kg $ha^{-1}$ as compared to August 30$^{th}$. Crop sown on July 30$^{th}$ showed per cent reduction in grain yield and straw yield (19.80 and 20.71%, respectively), August 15$^{th}$ (41.25 and 39.38%) and August 30$^{th}$ (50.03 and 45.02%, respectively) over July 15$^{th}$. The highest grain yield obtained in July 15$^{th}$ sown crop was mainly due to the during crop growth period crop received favorable temperature during vegetative and reproductive phases resulting higher biomass and photosynthates accumulation. Flowering initiation to grain filling stage of July 15$^{th}$ sowing crop from 33$^{rd}$ to 40$^{th}$ standard meteorological week that favoured with good rainfall and temperature.

During this period, average rainfall (380.2 and 89.4 mm during 2015 & 2016, respectively) accompanied with moderate minimum and maximum temperature (30.27 and 22.26° C, respectively) during 2015 and 2016 (29.61 and 20.72 °C, respectively) during 2015 enhanced net photosynthetic partitioning, which eventually made great contribution to higher grain yield. The delay in sowing dates for greengram decreased the grain yield by 62.45 per cent as compared to July 15$^{th}$ of sowing. The possible reason for decline in grain yield for late planting (August 30$^{th}$) sink organ formation to sink accumulation stage come under 40 to 46 SMW in this period rainfall decreases (220.8 and 43.8 mm) and slightly increase maximum temperature (30.73 and 31.93 ºC) in 2015 and 2016, respectively caused water stress which resulted in decline in grain number and grain weight. The maximum temperature reported during the late planting date *i.e.,* October was more than 30 °C which might have favoured the phenomenon explained above.

The higher yield obtained timely sowing was due to favorable temperature and humidity during their growth period resulting in better growth that was supported by Ansari *et al.* (2019) [2]. Greengram is more sensitive to change in rainfall than temperature. Rise in temperature by 1 to 2°C, reduced days to physiological maturity by 2 to 3 days and yield by 1.7 to 3.5 per cent. On the contrary, reduction in 20 per cent rainfall alone reduced grain yield and total biomass by 9.5 per cent and 10.48 per cent, respectively. Combined effect of reduced rainfall (-20%) and elevated temperature (2 °C) resulted in 16.36 and 21.16 per cent reduction in grain yield and total biomass, respectively. This indicates that, rainfall plays greater role on *Kharif* greengram yield in Southern Transtional Zone (Dhage and Patil, 2020) [4].

**Table 1:** Grain yield, haulm yield, harvest index and test weight of greengram as influenced by varieties and different dates of sowing

| Treatments | Yield | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grain yield (kg ha$^{-1}$) | | | Haulm yield (kg ha$^{-1}$) | | | Harvest Index | | | Test weight (g) | | |
| | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| Varieties (G) | | | | | | | | | | | | |
| $G_1$: KKM-3 | 872.45 | 740.36 | 806.41 | 3305.05 | 3107.24 | 3206.14 | 26.05 | 23.82 | 24.93 | 36.22 | 35.92 | 36.07 |
| $G_2$: PDM 84-178 | 744.46 | 606.96 | 675.71 | 2825.16 | 2571.94 | 2698.55 | 26.17 | 23.88 | 25.03 | 43.60 | 43.32 | 43.46 |
| $G_3$: SBM-1 | 673.26 | 548.36 | 610.81 | 2571.70 | 2353.77 | 2462.74 | 25.97 | 23.24 | 24.61 | 46.87 | 46.61 | 46.74 |
| S.Em± | 14.45 | 23.44 | 16.61 | 61.42 | 110.03 | 74.80 | 0.40 | 0.55 | 0.34 | 1.09 | 1.10 | 1.10 |
| C.D. (P=0.05) | 42.39 | 68.74 | 48.72 | 180.14 | 322.70 | 219.39 | NS | NS | NS | 3.21 | 3.23 | 3.22 |
| Dates of sowing (D) | | | | | | | | | | | | |
| $D_1$: July 15$^{th}$ | 1058.46 | 873.37 | 965.92 | 3869.39 | 3697.76 | 3783.57 | 27.37 | 23.68 | 25.52 | 42.36 | 42.07 | 42.21 |
| $D_2$: July 30$^{th}$ | 845.29 | 703.91 | 774.60 | 3076.98 | 2922.30 | 2999.64 | 27.47 | 24.05 | 25.76 | 42.34 | 42.06 | 42.20 |
| $D_3$: August 15$^{th}$ | 630.48 | 504.40 | 567.44 | 2416.70 | 2170.32 | 2293.51 | 26.16 | 23.24 | 24.70 | 42.64 | 42.36 | 42.50 |
| $D_4$: August 30$^{th}$ | 519.33 | 445.89 | 482.61 | 2239.47 | 1920.22 | 2079.85 | 23.25 | 23.64 | 23.44 | 41.58 | 41.30 | 41.44 |
| S.Em± | 16.69 | 27.06 | 19.18 | 70.92 | 127.05 | 86.38 | 0.47 | 0.63 | 0.39 | 1.26 | 1.27 | 1.27 |
| C.D. (P=0.05) | 48.95 | 79.38 | 56.25 | 208.00 | 372.62 | 253.33 | 1.37 | NS | 1.15 | NS | NS | NS |

**Table 2:** Interaction effect of varieties and different dates of sowing on grain yield, haulm yield, harvest index and test weight of green gram

| Varieties | Dates of sowing (D) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $D_1$: July 15$^{th}$ | | | $D_2$: July 30$^{th}$ | | | $D_3$: August 15$^{th}$ | | | $D_4$: August 30$^{th}$ | | |
| Grain yield (kg ha$^{-1}$) | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| $G_1$: KKM-3 | 1365.00 | 1140.71 | 1252.86 | 937.19 | 820.45 | 878.82 | 667.63 | 547.59 | 607.61 | 520.00 | 452.67 | 486.33 |
| $G_2$: PDM 84-178 | 965.67 | 774.17 | 869.92 | 844.30 | 670.42 | 757.36 | 634.87 | 540.58 | 587.73 | 533.00 | 442.67 | 487.83 |
| $G_3$: SBM-1 | 844.73 | 705.23 | 774.98 | 754.38 | 620.85 | 687.62 | 588.94 | 425.03 | 506.98 | 505.00 | 442.33 | 473.67 |
| S.Em± | 28.91 | 46.88 | 33.22 | 28.91 | 46.88 | 33.22 | 28.91 | 46.88 | 33.22 | 28.91 | 46.88 | 33.22 |
| C.D. (P=0.05) | 84.78 | 137.49 | 97.43 | 84.78 | 137.49 | 97.43 | 84.78 | 137.49 | 97.43 | 84.78 | 137.49 | 97.43 |
| Haulm yield (kg ha$^{-1}$) | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| $G_1$: KKM-3 | 4989.62 | 4834.47 | 4912.04 | 3383.49 | 3304.62 | 3344.05 | 2552.45 | 2406.53 | 2479.49 | 2294.67 | 1883.33 | 2089.00 |
| $G_2$: PDM 84-178 | 3535.47 | 3275.51 | 3405.49 | 3094.60 | 2839.27 | 2966.94 | 2321.48 | 2284.63 | 2303.06 | 2349.08 | 1888.33 | 2118.71 |
| $G_3$: SBM-1 | 3083.09 | 2983.28 | 3033.19 | 2752.85 | 2623.01 | 2687.93 | 2376.19 | 1819.80 | 2097.99 | 2074.67 | 1989.00 | 2031.83 |
| S.Em± | 40.94 | 73.35 | 49.87 | 40.94 | 73.35 | 49.87 | 40.94 | 73.35 | 49.87 | 40.94 | 73.35 | 49.87 |
| C.D. (P=0.05) | 122.84 | 220.05 | 149.61 | 122.84 | 220.05 | 149.61 | 122.84 | 220.05 | 149.61 | 122.84 | 220.05 | 149.61 |
| Harvest Index | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| $G_1$: KKM-3 | 27.39 | 23.70 | 25.54 | 27.71 | 24.81 | 26.26 | 26.32 | 22.75 | 24.54 | 22.76 | 24.03 | 23.40 |
| $G_2$: PDM 84-178 | 27.33 | 23.64 | 25.49 | 27.29 | 23.61 | 25.45 | 27.34 | 23.65 | 25.49 | 22.71 | 24.64 | 23.68 |
| $G_3$: SBM-1 | 27.38 | 23.70 | 25.54 | 27.41 | 23.72 | 25.57 | 24.82 | 23.32 | 24.07 | 24.26 | 22.23 | 23.25 |
| S.Em± | 0.81 | 1.10 | 0.68 | 0.81 | 1.10 | 0.68 | 0.81 | 1.10 | 0.68 | 0.81 | 1.10 | 0.68 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Test weight (g) | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| $G_1$: KKM-3 | 37.50 | 37.20 | 37.35 | 35.87 | 35.57 | 35.72 | 36.73 | 36.43 | 36.58 | 34.77 | 34.47 | 34.62 |
| $G_2$: PDM 84-178 | 42.50 | 42.20 | 42.35 | 43.46 | 43.19 | 43.32 | 44.10 | 43.83 | 43.97 | 44.33 | 44.07 | 44.20 |
| $G_3$: SBM-1 | 47.07 | 46.80 | 46.93 | 47.70 | 47.43 | 47.47 | 47.09 | 46.82 | 46.96 | 45.63 | 45.36 | 45.50 |
| S.Em± | 0.73 | 0.74 | 0.73 | 0.73 | 0.74 | 0.73 | 0.73 | 0.74 | 0.73 | 0.73 | 0.74 | 0.73 |
| C.D. (P=0.05) | 2.19 | 2.22 | 2.19 | 2.19 | 2.22 | 2.19 | 2.19 | 2.22 | 2.19 | 2.19 | 2.22 | 2.19 |

In the present study, it has been observed that the variety KKM-3 gave significantly higher grain yield (806.41 kg ha$^{-1}$) and haulm yield (3206.14 kg ha$^{-1}$) than PDM 84-178 (675.71 kg ha$^{-1}$ and 2698.55 kg ha$^{-1}$, respectively) and SBM-1 (610.81 kg ha$^{-1}$ and 2462.74 kg ha$^{-1}$, respectively) (Table 1). Variety KKM-3 showed per cent increase in grain and straw yield over variety PDM 84-178 (16.20% and 15.83%, respectively) and SBM-1 (24.25% and 23.18%, respectively). The overall trend revealed that KKM-3 recorded highest yield attributes. Thus, wide variations in yield attributing parameters persisted among the different varieties obtained from the different parental origin. Attainments of particularly higher or lower yield attributing character among the different varieties are the genetically controlled phenomenon. Such variations in yield attributes among the greengram varieties have also been observed by several research workers. (Kumar and Kumawat, 2014) [8].

Among the interactions, variety KKM-3 sown on 15$^{th}$ July recorded significantly higher grain and straw yield (1252.86kg ha$^{-1}$ and 4912.04 kg ha$^{-1}$, respectively) followed by sowing KKM-3 on 30$^{th}$ of July (878.82 kg ha$^{-1}$ and 3344.05 kg ha$^{-1}$, respectively) and it was found on par with PDM 84-178 sown on 15$^{th}$ of July (869.92 kg ha$^{-1}$and 3405.49 kg ha$^{-1}$, respectively) compared to variety SBM-1 on 15$^{th}$ July (774.98 kg ha$^{-1}$ and 3033.19 kg ha$^{-1}$, respectively) (Table 2). PDM 84-178 sown on July 30$^{th}$ got lesser grain yield and haulm yield (757.36 kg ha$^{-1}$ and 2966.94 kg ha$^{-1}$, respectively) followed by SBM-1 sown on at July 30$^{th}$ (687.62 and 2687.83, respectively). Significantly lesser grain yield and haulm yield obtained in variety SBM-1 sown on August 30$^{th}$ (473.67 kg ha$^{-1}$ and 2031.83 kg ha$^{-1}$, respectively) found on par with variety PDM 84-178 sown on August 30$^{th}$ (487.83 and 2118.71 kg ha$^{-1}$, respectively) and variety KKM-3 sown on August 30$^{th}$ (486.33 and 2089.00 kg ha$^{-1}$, respectively). The timely sowing gave higher yield in comparison to delayed sowing. This was mainly because of higher dry matter accumulation and yield attributing characters and also genetic potential and performance of various varieties under different dates of sowing.

**Table 3:** Clusters plant$^{-1}$, pods plant$^{-1}$, seeds pod$^{-1}$and pod length (cm) of greengram as influenced by varieties and different dates of sowing

| Treatments | Clusters plant$^{-1}$ (numbers) | | | Pods plant$^{-1}$ (numbers) | | | Seeds pod$^{-1}$ (numbers) | | | Pod length (cm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| **Varieties (G)** | | | | | | | | | | | | |
| $G_1$: KKM-3 | 11.59 | 9.35 | 10.47 | 43.18 | 34.84 | 39.01 | 10.40 | 9.99 | 10.21 | 8.29 | 7.93 | 8.11 |
| $G_2$: PDM 84-178 | 8.80 | 7.09 | 7.95 | 39.58 | 31.93 | 35.76 | 9.95 | 9.54 | 9.75 | 11.52 | 11.02 | 11.27 |
| $G_3$: SBM-1 | 7.38 | 5.95 | 6.67 | 27.30 | 22.02 | 24.66 | 8.72 | 8.32 | 8.52 | 13.58 | 12.99 | 13.29 |
| S.Em± | 0.26 | 0.21 | 0.24 | 1.13 | 0.94 | 1.03 | 0.18 | 0.18 | 0.18 | 0.06 | 0.06 | 0.06 |
| C.D. (P=0.05) | 0.76 | 0.63 | 0.70 | 3.32 | 2.75 | 3.03 | 0.53 | 0.53 | 0.53 | 0.19 | 0.18 | 0.18 |
| **Dates of sowing (D)** | | | | | | | | | | | | |
| $D_1$: July 15$^{th}$ | 10.80 | 8.72 | 9.76 | 43.55 | 35.16 | 39.35 | 10.23 | 9.83 | 10.03 | 11.64 | 11.14 | 11.39 |
| $D_2$: July 30$^{th}$ | 8.68 | 7.00 | 7.84 | 34.65 | 27.95 | 31.30 | 10.16 | 9.86 | 9.96 | 11.08 | 10.60 | 10.84 |
| $D_3$: August 15$^{th}$ | 9.41 | 7.58 | 8.50 | 36.84 | 29.70 | 33.27 | 9.46 | 9.05 | 9.26 | 10.83 | 10.36 | 10.60 |
| $D_4$: August 30$^{th}$ | 8.14 | 6.56 | 7.35 | 31.71 | 25.57 | 28.64 | 8.80 | 8.39 | 8.60 | 10.98 | 10.50 | 10.74 |
| S.Em± | 0.30 | 0.25 | 0.27 | 1.31 | 1.08 | 1.19 | 0.21 | 0.21 | 0.21 | 0.07 | 0.07 | 0.07 |
| C.D. (P=0.05) | 0.88 | 0.73 | 0.80 | 3.84 | 3.17 | 3.50 | 0.61 | 0.62 | 0.61 | 0.21 | 0.21 | 0.21 |

**Table 4:** Interaction effect of varieties and different dates of sowing on clusters plant$^{-1}$, pods plant$^{-1}$, seeds pod$^{-1}$and pod length (cm) in greengram

| Varieties | Dates of sowing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $D_1$: July 15$^{th}$ | | | $D_2$: July 30$^{th}$ | | | $D_3$: August 15$^{th}$ | | | $D_4$: August 30$^{th}$ | | |
| **Number of clusters plant$^{-1}$** | **2015** | **2016** | **Pooled** | **2015** | **2016** | **Pooled** | **2015** | **2016** | **Pooled** | **2015** | **2016** | **Pooled** |
| $G_1$: KKM-3 | 15.04 | 12.14 | 13.59 | 11.15 | 8.99 | 10.07 | 10.67 | 8.59 | 9.63 | 9.53 | 7.69 | 8.61 |
| $G_2$: PDM 84-178 | 9.63 | 7.77 | 8.70 | 9.21 | 7.40 | 8.30 | 8.22 | 6.63 | 7.42 | 7.70 | 6.21 | 6.96 |
| $G_3$: SBM-1 | 9.33 | 7.53 | 8.43 | 7.74 | 6.25 | 6.99 | 7.19 | 5.79 | 6.49 | 5.26 | 4.24 | 4.75 |
| S.E.m± | 0.52 | 0.43 | 0.47 | 0.52 | 0.43 | 0.47 | 0.52 | 0.43 | 0.47 | 0.52 | 0.43 | 0.47 |
| C.D. (P=0.05) | 1.52 | 1.26 | 1.39 | 1.52 | 1.26 | 1.39 | 1.52 | 1.26 | 1.39 | 1.52 | 1.26 | 1.39 |
| Number of pods plant$^{-1}$ | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| $G_1$: KKM-3 | 58.67 | 47.39 | 53.03 | 41.17 | 33.21 | 37.19 | 39.00 | 31.41 | 35.21 | 33.87 | 27.33 | 30.60 |
| $G_2$: PDM 84-178 | 43.33 | 34.97 | 39.15 | 42.24 | 33.56 | 37.90 | 37.00 | 28.81 | 33.41 | 34.67 | 27.96 | 31.31 |
| $G_3$: SBM-1 | 34.53 | 27.87 | 31.20 | 28.64 | 23.12 | 25.88 | 26.59 | 21.43 | 24.01 | 19.43 | 15.68 | 17.57 |
| S.E.m± | 2.27 | 1.87 | 2.07 | 2.27 | 1.87 | 2.07 | 2.27 | 1.87 | 2.07 | 2.27 | 1.87 | 2.07 |
| C.D. (P=0.05) | 6.65 | 5.49 | 6.07 | 6.65 | 5.49 | 6.07 | 6.65 | 5.49 | 6.07 | 6.65 | 5.49 | 6.07 |
| Number of seeds pod$^{-1}$ | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| $G_1$: KKM-3 | 11.30 | 10.89 | 11.10 | 11.20 | 10.79 | 11.00 | 10.33 | 9.93 | 10.13 | 8.77 | 8.36 | 8.56 |
| $G_2$: PDM 84-178 | 10.55 | 10.14 | 10.35 | 10.30 | 9.89 | 10.10 | 9.55 | 9.14 | 9.35 | 9.40 | 8.99 | 9.20 |
| $G_3$: SBM-1 | 8.63 | 8.25 | 8.44 | 9.20 | 8.79 | 9.00 | 8.80 | 8.39 | 8.60 | 8.23 | 7.83 | 8.03 |
| S.E.m± | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| C.D. (P=0.05) | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 |
| Pod length (cm) | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| $G_1$: KKM-3 | 8.73 | 8.35 | 8.54 | 8.27 | 7.91 | 8.09 | 7.83 | 7.49 | 7.66 | 8.33 | 7.97 | 8.15 |
| $G_2$: PDM 84-178 | 12.13 | 11.60 | 11.87 | 11.53 | 11.03 | 11.28 | 11.33 | 10.83 | 11.08 | 11.09 | 10.61 | 10.85 |
| $G_3$: SBM-1 | 14.07 | 13.45 | 13.76 | 13.43 | 12.85 | 13.14 | 13.50 | 12.91 | 13.21 | 13.33 | 12.75 | 13.04 |
| S.E.m± | 0.13 | 0.12 | 0.12 | 0.13 | 0.12 | 0.12 | 0.13 | 0.12 | 0.12 | 0.13 | 0.12 | 0.12 |
| C.D. (P=0.05) | 0.39 | 0.36 | 0.37 | 0.39 | 0.36 | 0.37 | 0.39 | 0.36 | 0.37 | 0.39 | 0.36 | 0.37 |

Grain yield is a manifestation of yield contributing characters. The present study showed significant variance in yield components *viz.*, number of clusters per plant, number of pods per plant, number of seeds per pod and pod length with respect to date of sowing. Among yield components, number of clusters per plant was more closely associated with grain yield. Crop sown on July 15$^{th}$ recorded significantly higher number of clusters per plant (9.76) followed by July 30$^{th}$ sowing (7.84) and its on par with August 15$^{th}$ (8.50) and August 30$^{th}$ (7.33) sowing, there by July 15$^{th}$ plants recorded nearly 19.69 per cent, 12.90 per cent and 25.20 per cent higher than July 30$^{th}$, 15$^{th}$ and August 30$^{th}$ sowings, respectively (Table 3). Grain yield further depends on number of pods per plant, number of seeds per pod and pod length. July 15$^{th}$ sowing had more pods per plant (39.35), number of seeds per pod (10.03) and pod length (11.39) when compared to other sowing dates. Crop sown on August 30$^{th}$ showed per cent reduction in yield components *viz.* number of pods per plant and number of seeds per pod and pod length (27.21%, 14.2% and 6.9% respectively) followed by August 15$^{th}$ (15.45%, 6.6% and 5.7%, respectively). Crop sown on July 15$^{th}$ realized higher yield components as compared to July 30$^{th}$, August 15$^{th}$ and August 30$^{th}$. But crop sown on July 30$^{th}$ (31.30, 9.36 in no. and 10.84 cm) and August 15$^{th}$ (33.27, 9.26 in no. and 10.72 cm) were on par with each other with respect to number of pods per plant, number of seeds per pod and pod length (Table 3). The increased dry matter accumulation in pods indicates the better translocation of the available photosynthates towards seed. The decrease of yield components with delayed sowing could be due to the fact that plant vegetative stage faces intense heat of the season which results in decrease of vegetative growth stage, production of fewer vegetative parts, decrease of assimilation, early flowering, increase of flower loss and infertility as a result decreased yield components. Soomro (2003) [19] reported that delaying sowing causes a substantial decrease in all the growth and development parameters of greengram. Siddique *et al.* (2006) [17] and Patil *et al.* (2003) also reported similar results to those obtained in the following study.

The higher number of seeds per plant was mainly because of higher seeds per pod but seed per pod was alone not directly contributed to final seed yield, test weight was also important to asses the final seed yield, Higher test weight recoded in variety SBM-1 (46.74 g) which is on par with PDM 84-178

(43.46 g) compare to KKM-3 (42.21 g) (Table 1). This variation among the genotypes was also noticed by Mudalagiriyappa *et al*. (2016) [11]. There was no significant difference in test weight among the different sowing dates.

Seed yield is governed by number of factors which have a direct or indirect impact.

Among the yield components, pod and seed yield per plant was more closely related with seed yields. Yield per plant is intern determined by other yield components. Among different varieties significantly higher yield components was noticed with variety KKM-3 like number of number of clusters plant$^{-1}$ (10.47), number of pods per plant (39.01) and number of seeds per pod (10.21) than PDM 84-178 (7.95 and 35.76 and 9.75, respectively) and SBM-1 (6.67, 24.66 and 8.52, respectively). Pod length (13.29 cm) and test weight (46.74 g) higher in SBM-1 it was found to be on par with PDM 84-178 (11.27 cm and 43.46 g) followed by KKM-3 (8.11 cm and 36.07 g) (Table 3 and 1). Variety KKM-3 showed per cent increase in yield components *viz.*, number of clusters plant$^{-1}$, number of pods plant$^{-1}$ and number of seeds per pod over PDM 84-178 (24.06%, 8.33% and 4.41%, respectively) and SBM-1 (35.5%, 36.7% and 16.47%, respectively). The differences in yield and yield attributing characters among the variety might be due to genetic constitution of different genotypes which provided inherent capacity to perform genotypes in different ways. This type of differences among the genotypes with respective yield and yield attributing character were observed by (Chauhan and Williams, 2018) [3].

Among the interactions significant difference was noticed between date of sowing and variety with respect to yield components, sowing of variety KKM-3 sown on July 15th recorded significantly higher number of clusters plant$^{-1}$, numbers of pods plant, numbers of seeds per pod (13.59, 53.03 and 11.10, respectively) compared to late sowing variety PDM 84-178 during August 30th (6.96, 31.31 and 8.56, respectively) and late sowing variety SBM-1 on August 30th (4.75, 17.57 and 8.03, respectively) (Table 4). The decrease of yield components with delayed sowing could be due to the fact that plant vegetative stage faces intense heat of the season which results in decrease of vegetative growth stage, production of fewer vegetative parts, decrease of assimilation, early flowering, increase of flower loss and infertility as a result decreased yield components. Due to regular availability of mild moisture throughout growing season especially at flowering and seed formation improved yield. Khan *et al.* (2001) reported that sowing date had significant effect on seed yield. The higher grain yield attributed to more number of pods plant$^{-1}$ (Sadeghipour, 2008) [14].

Malik (2008) and Sarkar *et al.* (2004) [15] also reported similar findings. SBM -1 sown on July 15th recorded significantly higher pod length (13.76 cm) compared late sown August 30th with KKM-3 (8.15 cm) and PDM 84-178 (10.85 cm) (Table 4), SBM-1 with early sowing recorded significantly higher pod length its mainly due to genetic potentiality of that variety but it does not compontiate the yield of that variety.

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