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Performance of mungbean (*Vigna radiata*) genotypes under delayed planting condition

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Abstract
The sowing dates at D1 i.e. (25th June) was found significantly superior in plant height (at harvest), branches (at harvest), functional leaves (at harvest), number of pod and pod yield (g) plant^{-1}, number of seeds pod^{-1} and grain weight plant^{-1},seed index, seed yield (kg ha^{-1})., straw yield (kg ha^{-1}) and biological yield (kg ha^{-1}) over rest of sowing dates treatments in case of plant height D2 was at par. The green gram variety BM-2003-2 recorded statically higher in plant height, branches, functional leaves, number of pod and pod yield (g) plant^{-1}, number of seeds pod^{-1} and grain weight plant^{-1},seed index, seed yield (kg ha^{-1})., straw yield (kg ha^{-1}) and biological yield (kg ha^{-1}) over rest of varieties.

Keywords: Green gram, variety and sowing date

Introduction
Mungbean (*Vigna radiata* L.) is a leguminous pulse crop in use as a vegetable protein source, animal fodder and green manure. It also play an important role in improving soil fertility through biological nitrogen fixation Asghar Malik *et al.* (2006) [2]. This is an important short duration (60-70 days) grain legume with high nutritive value. It is popular because of nutritional quality where meal is often to babies and convalescents, showing to their high digestibility and protein content (22-24%). Mungbean can play a major role in the national economy of india due to their wider adaptability easy digestibility and higher market price, Patil *et al.* (2003) [13] Being a short duration crop and having wider adaptability, it can be grown in *Kharif as well as summer* season.
The duration of each growth phase determines the accumulation and partitioning of dry matter in different plant organs as well as crop response to environmental factors. The duration of particular stages of growth is directly related to temperature and the duration for particular species could be predicted using the sum of daily air temperature. The data on the effect of dates of sowing were lacking on the new promising genotypes of mungbean. In addition, there was a dire need to find out genotypes for late sowing according to heat unit requirement. Further more the optimum time of sowing may vary different varieties of mungbean Sarkar *et al.* (2004) [16]. However information about response of newly developed mungbean cultivar to different sowing date is lacking. Therefore, an experiment was planned and conducted on different dates of sowing on *kharif* mungbean genotypes, so that these indices can be used as tools for characterizing thermal responses in different cultivars of mungbean.

Materials and Methods
The experiment was conducted at Agronomy farm, College of Agriculture, Badnapur and laid out in a split plot design with three replications. The main plot treatments were four sowing dates *viz*., D1: 25th June, D2: 6st July, D3: 16th July and D4: 26th July. The sub plot treatments comprised four varieties *viz*., V1: Phule Vaibhav, V2: BM 4, V3: BM 2003-2 and V4: PKV green gold. Thus, there were in all 16 treatment combinations. The seed of varieties Phule Vaibhav, BM-4, BM-2003-2, and PKV green gold was sown as per the treatments. The seed was dibbled at 30 cm X 10 cm spacing. Before sowing the seed was treated with *thirum@* 4 g per kg of seed followed, by *Rhizobium* and PSB @ 25 g per kg of seed. Nitrogen and phosphorus were applied in the form of urea (46 % N) and single Super phosphate (16 % P2O5) as 25:50:00 kg N:P_2O_5:K_2O per hector . The whole quantity of fertilizers was applied as a basal dose before sowing. The other usual common packages of practices were followed time to time and periodical growth observations were recorded at an interval of 15 days. Crop was harvested at physiological maturity and data on yield attributes and yield were recorded.

Result and Discussion, Effect of sowing dates and Effect on plant height

The mean plant height, of D1 (25th June) is significantly superior over D3 (16th July), D4 (26st July) treatments at all growth stages and at par with D2 (6th July) at all growth stages i.e. (26st July). Fraz *et al.* (2006) [7] and Sadeghipour, (2008) [14] also reported similar ratio to mungbean. This result confirms the observations of Malik *et al.* (2006) [2] and Ram and Dixit (2000) [5].

Effect on branches

The number of branches increased up to 60 days and remained constant in 60 DAS to harvest. The sowing dates D_1(25th June) recorded highest number of branches plant^{-1} over the sowing time D_2, D_3, D_4 at all growth stages. These results are similar to the Singh *et al.* (2010) [20].

Effect on functional leaves

The functional leaves increased rapidly up to 30 days and whereas moderately between 31-45 days and decreased there after towards maturity due to senescence of leaves. The crop sown on D_1 i.e. (25th June) recorded more number of functional leaves plant^{-1} from 15 DAS to at harvest over rest of all other sowing dates except 30 DAS it was followed by with D_2 i.e. (6st July). The higher mean number of functional leaves recorded by D_1 i.e. (25th June) at every stages of crop growth due to long vegetative period, bright sunshine and high rainfall which favoured more vegetative growth. These results agree to those of Singh and Singh. (2010) [20].

Effect on number of pod and pod yield (g) plant^{-1}

The sowing of D_1 i.e. (25th June) was recorded significantly higher number of pods (10.78) and pod yield plant^{-1} (6.21 g) as crop sowing on D_1 i.e. (25th June) has produced highest pod weight plant^{-1} and significantly superior over rest of the sowing dates and it was found followed by date D_2 i.e. (6stJuly).

Effect on number of seeds pod^{-1} and grain weight plant^{-1}

The sowing of D_1 i.e. (25th June) was recorded significantly higher number of seed pod^{-1} (8.58) and grain weight plant^{1} (3.84g) which was over other sowing dates followed by D_2 i.e. (6st July). These results are supported by Sadeghipour, (2008) [14] and Sarkar *et al* (2004) [16]. Higher yield attributes observed in first sowing date thus, due to the favourable climatic conditions to crop growth.

Effect on seed index

The treatment D_1 i.e. (25th June) produced higher 100 seed weight (4.15g) while sowing date D_4 i.e. (26th July) produced lower 100 seed weight (3.55). There results were confirmed with Nag *et al* (2000).

Effect on seed yield (kg ha^{-1})

The mean seed yield (kg ha^{-1}) as influenced by different sowing dates was showed that the date D_1 i.e. (25th June) produced maximum seed yield 1156 (kg ha^{-1}) which was significantly superior over rest of sowing dates followed by D_2 i.e. (6st July) due to the favorable climatic conditions to crop growth. Maih *et al* (2009) and Sadeghipour (2008) [14] reported that seed yield was reduced by delaying in sowing of crop. The result are confirmed by Aziz *et al* (2005) and Sharma *et al* (1989) and Dhanjal *et al*. (2000).

Effect on straw yield (kg ha^{-1}) and biological yield (kg ha^{-1})

The straw yield (kg ha^{-1}) as influenced by different sowing dates was found to be significant. The sowing date D_4 i.e. (26st July) 952 (kg ha^{-1}) produce recorded lowest straw yield (kg ha^{-1}) than other dates and date D_1 i.e. (25th June) 1723 (kg ha^{1}) recorded significantly higher straw yield rest of the dates followed by D_2 i.e. (6st July). The sowing date D_1 i.e. (25th June) recorded maximum biological yield 2878 (kg ha^{-1}) of green gram which was significantly superior over rest of the sowing dates followed by D_2 i.e. (6st July). Similar trend in seed, straw and biological yield of green gram observed by Taleei *et al.* (1999).

Effect of variety

Effect on plant height

All the four green gram varieties recorded more or less similar plant height in early stage which might be due to slow growth during seedling stage. During later stages, variety BM 2003-02 produced taller plants (Table 1) as compared to BM-4, Phule Vaibhav, and PKV green gold. Among the varieties BM 2003-02 accommodates maximum plants per unit area and also showed the tallest plant. The similar differences in different green gram varieties in respect of height were reported by Kumar and D. Nandan (2004).

Effect on number of functional leaves

In number of leaves variety BM 2003-02 significantly superior over BM- 4, Phule Vaibhav and PKV green gold at all stages of crop growth. Which may be attributed to differential maturity period and genetic potential. These result are similar to the Singh and Faroda (1982)

Effect on number of branches

The variety BM 2003-2 (V_3) was found significantly superior in number of branches over varieties Phule Vaibhav (V_1), BM-4 (V_2) and PKV green gold (V_4) for producing maximum number of branches plant^{-1}. These result are similar to the Singh *et al.* (2010) [20].

Effect on number of pods plant^{-1} and weight of pods plant^{-1}

The maximum number of pod plant^{-1} were observed in BM-4 variety and weight of pods plants^{-1}were observed in BM-2003-2 variety. The different might be due to genetic makeup of cultivar. Similar resulted by Ayub et al (1999) and khan and malik (2001) [8].

Effect on number of seeds pod^{-1}and grain weight plant^{-1}

The maximum number of seeds pod^{-1} and seed yield plant^{-1} were observed in BM 2003-2 variety. Singh and Farode (1982) Tomor *et al.* (1993) also observed differences in yield attributing characters under different varieties of green gram.

Effect on Seed index

Due to seasonal effect variety BM 2003-02 recorded higher test weight (4.30gm) as compared to other varieties whereas variety BM-4 were recorded lowest test weight (3.36 gm) as compared to other varieties.

Effect on seed yield ha^{-1}

The green gram variety BM 2003-02 recorded higher seed yield of 1012 kg ha^{-1}. This increase in seed yield of BM 2003-02 might be due to higher production efficiency which was reflected through improvement in different yield contributing

characters. Bhise *et al*. (2010) also present study the tested variety has bold seeds, which required optimum sowing date to ensure optimum environmental condition. The higher seed yield was attributed to more number of pods plant^{-1} and number seeds pod^{-1}. Similar result were reported by Samant *et al* (1999) Kuradikeri and Nadagoudar (1973) from different locations.

Effect on straw yield and biological yield (Kg ha^{-1})

Green gram genotypes BM 2003-02 produced higher straw yield 1508 (kg ha^{-1}) and biological yield 2521 (kg ha^{-1}).The higher biological yield of BM 2003-02 as compared to BM-4, Phule Vaibhav, and PKV green gold. Such of findings in case of green gram variety were reported by Dixit and Swain (1987) [5].

Table 1: Mean plant height (cm), number of functional leaves plant^{-1} and Mean number of branches plant^{-1} as influenced by various treatments.

Treatment	Days after sowing Mean plant height (cm)				At harvest	Days after sowing Mean number of functional leaves plant^{-1}				At harvest	Days after sowing Mean number of branches plant^{-1}				At harvest
	15	30	45	60		15	30	45	60		15	30	45	60	
Sowing dates (D)															
D1 : 25th June	7.45	14	25.68	30.31	30.31	5.73	11.25	17.50	20.60	19.60	1.23	3.08	5.16	6.20	6.20
D2 : 06st July	7.18	13.46	24.78	28.70	28.70	5.20	10.55	16.45	19.05	17.97	1.03	2.85	4.81	5.68	5.68
D3 : 16th July	6.60	12.56	22.60	27.51	27.51	4.71	9.73	15.60	18.25	17.25	0.83	2.53	4.53	5.41	5.41
D4 : 26th July	5.63	11.23	19.66	24.55	24.55	4.10	8.90	14.75	17.40	16.40	0.56	2.31	4.28	5.13	5.13
SE ±	0.26	0.35	0.46	0.74	0.74	0.08	0.26	0.14	0.10	0.11	0.03	0.06	0.04	0.03	0.03
CD at 5 %	0.77	1.02	1.35	2.16	2.16	0.25	0.76	0.41	0.32	0.38	0.11	0.19	0.13	0.10	0.10
Varieties (V)															
V1 : Phule Vaibhav	6.85	12.98	23.50	28.15	28.15	5.11	10.25	16.25	19.15	18.07	1.01	2.76	4.75	5.71	5.71
V2 : BM- 4	6.23	12.26	22.33	26.56	26.56	4.13	9.23	15.05	17.60	16.60	0.56	2.35	4.35	5.20	5.20
V3: BM 2003-2	7.25	13.53	24.08	28.93	28.93	5.86	11.35	17.40	20.20	19.20	1.28	3.11	5.13	6.06	6.06
V4:PKV green gold	6.53	12.48	22.75	27.43	27.43	4.63	9.6	15.60	18.35	17.35	0.80	2.55	4.56	5.45	5.45
SE ±	0.16	0.30	0.38	0.37	0.37	0.07	0.12	0.10	0.09	0.11	0.02	0.02	0.03	0.03	0.03
CD at 5 %	0.47	0.88	1.11	1.40	1.40	0.20	0.37	0.30	0.28	0.33	0.07	0.08	0.10	0.09	0.09
Interaction (D x V)															
SE ±	0.32	0.60	0.76	0.75	0.75	0.14	0.25	0.21	0.19	0.40	0.05	0.05	0.06	0.06	0.06
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
General Mean	6.71	12.81	23.16	27.7	27.7	4.93	10.10	16.07	18.82	17.80	0.91	2.69	4.70	5.60	5.60

Table 2: Mean number of pods plant^{-1}, weight of pod plant^{-1}, Grain weight plant^{-1}, number of seed pod^{-1}, Seed index, Seed yield (kg ha^{-1}), Straw yield (kg ha^{-1}), Biological yield (kg ha^{-1}) and Harvest index (%) as influenced by various treatments.

Treatments	No. of pods plant^{-1}	Wt. of pods plant^{-1}	Grain weight plant^{-1} (g)	No. of seeds pod^{-1}	Seed index (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Sowing dates (D)									
D1 : 25th June	10.78	6.21	3.84	8.58	4.15	1156	1723	2878	40.01
D2 : 06st July	10.38	5.53	3.47	8.33	3.95	1097	1660	2757	39.75
D3 : 16th July	8.33	4.54	2.30	7.76	3.77	769	1169	1938	39.64
D4 : 26th July	7.68	3.46	1.96	6.90	3.55	621	952	1574	39.51
SE ±	0.18	0.54	0.37	0.28	0.01	37.71	60.50	97.39	0.04
CD at 5 %	0.55	1.64	1.11	0.81	0.05	109.92	176.34	283.83	0.12
Varieties (V)									
V : Phule Vaibhav	8.83	4.72	3.11	8.78	4.00	942	1413	2355	40.00
V2:BM 4	11.30	2.15	1.97	5.11	3.36	799	1231	2030	39.26
V3: BM 2003-2	7.71	5.25	3.90	10.56	4.30	1012	1508	2521	40.13
V4:PKV green gold	9.34	3.75	2.59	7.22	3.76	888	1353	2241	39.51
SE ±	0.21	0.45	0.34	0.47	0.03	34.95	21.13	30.21	0.08
CD at 5 %	0.63	1.36	1.02	1.37	0.09	102.03	61.60	88.06	0.25
Interaction (D x V)									
SE ±	1.82	2.08	2.11	0.94	0.06	69.91	42.27	60.43	0.17
CD at 5 %	5.46	6.2	6.34	NS	NS	NS	NS	NS	NS
General Mean	9.29	4.94	2.89	7.92	3.86	910.67	1376.6	2287.3	39.73

Conclusion

On the basis of the field experimentation for a season, it could be concluded that

1. Among different sowing dates in green gram, the sowing date D_1 i.e. (20th June) was found optimum for achieving higher seed yield.
2. The green gram variety BM 2003-2 was found high yielding as compared to Phule Vaibhav, BM-4 and PKV green gold.

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