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Effect of different dates of planting and varieties on the growth and yield of summer mung (*Vigna radiata* L.) under Manipur valley condition

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Abstract
An experiment was conducted at the experimental field of College of Agriculture, Central Agricultural University, Imphal during the summer season of 2016 to study the performance of different summer mung (greengram) varieties sown at different dates**.** The experiment consisted of five varieties- DGSS-4 (V_1), HUM-16 (V_2), HUM-2 (V_3), HUM-6 (V_4) and HUM-12 (V_5) and three dates of sowing- 24th February (D_1), 5th March (D_2) and 15th March (D_3) and was laid out in factorial randomized block design with three replications. The results indicated that sowing on D_3 recorded máximum root weight (0.77 g), seed yield (1081.55 kg ha^{-1}), straw yield (2352.38 kg ha^{-1}), harvest index (30.87) and the variety, V_2 recorded least number of days for 50% germination (13) and 50% flowering (40.99) and recorded máximum root length (13.68 cm), pod length (8.69cm) and 100 seed weight (5.86 g) amongst all the varieties.

Keywords: *Vigna mungo*, harvest index, pod and pulses

Introduction
Pulses are the second most important food crops after cereals and are the main source of vegetable protein. India is the largest producer and consumer of pulses occupying 33% of the world's area and 22% in the production. The area under pulse crops in India during 2013-2014 is around 3.38 million ha with production of 1.61 million tones and productivity of about 474 kgha^{-1} (Anonymous 2016) [2]. Although, India being the largest pulse crop cultivating country in the world, pulses share to total food grain is production is only 6-7% in the country. Pulses provide energy, dietary fibre, protein, minerals and vitamins required for human health. It provides 25 per cent of protein requirements of predominantly vegetarian population and 14% of total protein of an average Indian diet. The World Health Organisation (WHO) recommends a per capita consumption of pulses at 80 g per day and the Indian Council of Medical Research has recommended a minimum consumption of 47 g. In comparison to other vegetables, pulses are rich in protein and contribute about 10 percent in the daily protein intake and 5 percent in energy intake, are of particular importance for food security in low income countries, where the major sources of proteins are non-animal products. In addition, pulses also contain significant amounts of other essential nutrients like calcium, iron and lysine. In Manipur, it covers an area of 30.22 thousand hectares with a production of 28.44 thousand tones and productivity of 0.94 MTha^{-1} (Anonymous, 2013-14) [1].
India is the largest producer of mungbean which accounts for 65 percent of the world's area and shares 54 percent of the world's production. The important mungbean growing states are Rajasthan, Maharashtra, Madhya Pradesh, Tamil Nadu, Andhra Pradesh Karnataka, Odisha, Bihar and annual production of mungbean is about 1.8 million tones (Soren *et al*., 2012) [20].
One of the major requirements in crop planning is to determine the best planting time. It is an important factor that influence vegetative and reproductive growth period. It also affects other production factors, harvest, quality and ultimately crop yield and quality. Timely sowing of this crop is of paramount importance to obtain the best out of the varieties. Any delay in sowing not only reduces the yield but creates problem for harvesting of the same if caught by pre-monsoon showers. Optimum date of sowing of mungbean may vary from variety to variety and season to season due to variation in agro-ecological conditions. Therefore, there must be specific date of sowing for different varieties to obtain maximum yield.

Mungbean is well adapted in Manipur due to its congenial agro-climatic condition. By the introduction of numerous short duration varieties in green gram it can be feasible to introduce green gram in multiple cropping systems for increasing pulse production. Summer cultivation of green gram is being pushed to adjust between the time left after the harvesting of rabi and sowing of kharif crops, where incidence of diseases and pests are relatively low and also the vacant land is efficiently utilized without affecting the main crops. The period from later part of November after rice harvest to early part of June remains fallow which can be successfully utilized for cultivation of short duration legumes like mungbean as the research on summer mungbean in Manipur is not yet reported earlier.

Materials and Methods

The experiment was conducted at College of Agriculture, Central Agricultural University, Imphal during the summer season of 2016. The soil of the experimental field was clay type having a pH of 5.4. The organic carbon content was high (1.07%) and medium in available nitrogen (301.0 $kgha^{-1}$), phosphorous (20.23 $kgha^{-1}$) and potassium (314.50 $kgha^{-1}$). The mean minimum and maximum temperature recorded during the cropping season was 15.5 and 27.5 °C, respectively. The total rainfall recorded was 22.8 mm. The average relative humidity in the morning hours was 88.0% and in the evening 58.1%. The average bright sunshine hours ranged was 5.9 and wind speed recorded 5.4 km hr^{-1}.

The experiment was laid out in factorial randomized block design and replicated thrice consisting of 15 treatments *viz.*, 24th Feb + DGGS-4 (T_1), 24th Feb + HUM-16 (T_2), 24th Feb + HUM-2 (T_3), 24th Feb + HUM-6 (T_4), 24th Feb + HUM-12 (T_5), 5th March + DGGS-4 (T_6), 5th March + HUM-16 (T_7), 5th March + HUM-2 (T_8), 5th March + HUM-6 (T_9), 5th March + HUM-12 (T_{10}), 15th March + DGGS-4 (T_{11}), 15th March + HUM-16 (T_{12}), 15th March + HUM-2 (T_{13}), 15th March + HUM-6 (T_{14}) and 15th March + HUM-12 (T_{15}) respectively. Recommended dose of N, P and K (20: 40: 40 Kg N, P_2O_5 and K_2O kg ha^{-1}) was applied in the form of Urea, SSP and MOP respectively. The entire quantity of fertilizer was applied at the time of sowing to all the plots equally. Bold and healthy seeds were selected. Twenty days after sowing, the seedlings were thinned to maintain only two plants per spot in order to maintain the desired plant population. During the experimental period to prevent pest and disease incidence suitable insecticide Imidacloprid was sprayed at 20-25 days for controlling stem fly and thrips. To keep the entire plots weed free during the crop growth period Pendimethalin @ 0.1 kg *a.i.* per hectare as pre emergence spray followed by two hands weeding at 30 and 45 days after sowing were carried out for all the plots to keep the experimental site clean and reduce the crop weed competition. Drainage was done during the heavy rains as and when required, to avoid water stagnation in the field.

Results and Discussion

Days to 50% germination: Number of days was least (12.33) observed from D_3 (15th March) and more number of days (14.80) was required for D_1 (24th February). Number of days required for 50% germination is higher in early sowing. This might be due to lower temperature and low soil moisture content compare to late sowing. Similar results were also found by Yadav *et al.* (1995) [21]. HUM-16 required least number of days for germination (13.00) and more for HUM-2 (14.22). This might be due to genetic variation between the varieties. The results are in accordance with the findings of Rehman *et al.* (2009) [15].

Root length (cm): Root length (13.71 cm) was highest when sown on 15th March (D_3) 13.71 cm. It appears that weather conditions (temperature, soil moisture, sun light etc.) prevailed during nodule formation and flowering stages under delayed planting of mungbean were more conducive for root growth. This might be due to favourable temperature and moisture available for root growth and development. The establishment and growth of crop plants depend much on sound root system. It is also true to postulate that plants with better developed root system are able to absorb nutrients efficiently from different layers of the soil profile. Kumar *et al*. (2016) [9] reported similar findings. Highest root length was recorded from HUM-16 (V_2) with a root length of 13.68 cm. The result was contradictory to findings of Kumar *et al*. (2013) [7].

Root weight (g): Significantly higher root weight (0.77 g) per plant was observed from 15th March (D_3). This might be due to favourable temperature and moisture available for root growth and development. Kumar *et al.* (2016) [9] reported similar findings. No significant difference was observed in root weight at 30 DAS, 45 DAS and at harvest. This might be due to favourable weather condition and soil moisture content available to all the varieties. The result was contradictory to findings to the results of Kumar *et al*. (2013) [7].

Days to 50% flowering: Number of days *i.e.* 39.47 was least when sown on D_3 (15th March) and more (43.29) when sown on D_1 (24th February). Number of days required was reduced with delay in sowing. The resultant effect might be due to increased temperature and sufficient moisture content, Miah *et al.* (2009) [10]. Similar results are also found by Singh and Vashist (2005) [18] and Rehman *et al.* (2009) [15]. Days required for 50% flowering is more for HUM-2 variety (41.82) and least for HUM-16 (40.99). This might be due to genetic similarity between the varieties. Similar findings are also recorded by Rehman *et al.* (2009) [15].

Pod length (cm): Longer pod length was recorded when sown on 15th March (7.45 cm) and shorter when sown on 24th February (7.29 cm). Pod length increases with delayed in sowing due to higher temperature, higher moisture content and sunshine. Similar results were also reported by Singh and Sekhon (2005) [17] and Singh and Singh (2009) [19]. HUM-16 variety recorded longest pod length (8.69 cm), followed by DGGS-4 variety (8.15 cm) and HUM-2 variety recorded the shortest pod length (6.60 cm). This might be due to genotypic difference in the varieties. These results have the agreement with the results of Sarkar *et al*. (2004) who reported that pod length differed from varieties to varieties.

100 seed weight (g): Maximum seed weight(g) were recorded from 15th March (D_3) *i.e.* 4.29 g and minimum when sown on 5th March (D_2) *i.e.* 4.26 g. This might be due to favourable temperature and moisture content. These results are similar with the findings of Rehman *et al.* (2009) [15] and Singh and Singh (2009) [19]. Higher 100 seed weight was recorded significantly from HUM-16 variety *i.e.* 5.86 g, followed by DGGS-4 variety (4.05 g). While, significantly lower 100 seed weight was recorded from HUM-2 variety (3.66 g). This might be due to genotypic difference in the varieties. Similar findings are also reported by Singh and Singh (2009) [19], Begum *et al.* (2009) [3], Rehman *et al.* (2009) [15], Parvez *et al.* (2013) [11] and Bhowaland and Bhowmik (2014) [4].

Table 1: Effect of dates of planting and varieties on the growth and yield of greengram

Treatment	Days to 50 germination	Root length (cm)	Root weight (g)	Days to 50% flowering	Pod length (cm)	100 seed weight (g)	Straw yield ($kgha^{-1}$)	Harvest Index	Yield ($kgha^{-1}$)
Dates of sowing									
D_1	14.80	12.46	0.66	43.29	7.29	4.28	2264.64	29.47	972.91
D_2	13.53	13.27	0.72	41.42	7.41	4.26	2346.28	30.33	1049.78
D_3	12.33	13.71	0.77	39.47	7.45	4.29	2352.38	30.87	1081.55
S.E(d) (±)	0.30	0.26	0.01	0.25	0.06	0.05	27.94	0.36	22.58
CD (0.05)	0.61	0.53	0.02	0.51	0.12	NS	57.22	0.74	46.24
Varieties									
V_1	13.11	11.13	0.73	41.56	8.15	4.05	2390.17	30.56	1083.57
V_2	13.00	10.68	0.72	40.99	8.69	5.86	2353.34	30.56	1059.95
V_3	14.22	10.24	0.71	41.82	6.60	3.66	2210.41	30.33	988.84
V_4	14.11	10.92	0.71	41.37	6.68	3.78	2293.68	29.89	1003.23
V_5	13.33	11.28	0.72	41.23	6.79	4.04	2357.90	29.78	1038.14
S.E(d) (±)	0.37	0.38	0.03	0.32	0.08	0.06	36.07	0.46	29.15
CD (0.05)	0.76	NS	NS	NS	0.16	0.12	73.87	NS	59.70
Dates of sowing and varieties interaction									
T_1 (D_1 V_1)	14	13.17	0.68	43.03	8.09	4.04	2329.45	29.66	1015.42
T_2 (D_1 V_2)	14.33	13.03	0.65	43.14	8.68	5.82	2271.96	30.00	994.02
T_3 (D_1 V_3)	15.67	11.42	0.64	43.67	6.58	3.64	2213.31	29.33	949.22
T_4 (D_1 V_4)	15.33	11.44	0.67	43.47	6.44	3.85	2174.07	29.00	910.72
T_5 (D_1V_5)	14.67	13.22	0.66	43.13	6.67	4.03	2334.40	29.33	995.14
T_6 (D_2 V_1)	13.67	13.38	0.72	42.03	8.16	3.98	2420.67	30.33	1089.55
T_7 (D_2 V_2)	12.67	14.02	0.73	40.70	8.69	5.86	2368.60	30.33	1066.68
T_8 (D_2 V_3)	14.00	12.77	0.72	41.70	6.63	3.67	2189.73	31.00	1004.29
T_9 (D_2 V_4)	14.33	13.45	0.70	41.63	6.74	3.73	2324.27	30.67	1045.37
T_{10} (D_2 V_5)	13.00	12.72	0.72	41.01	6.81	4.07	2428.12	29.33	1043.00
T_{11} (D_3 V_1)	11.67	13.73	0.78	39.60	8.20	4.12	2420.39	31.67	1145.74
T_{12} (D_3 V_2)	12.00	14.00	0.77	39.13	8.72	5.88	2419.46	31.33	1119.16
T_{13} (D_3 V_3)	13.00	12.96	0.77	40.11	6.59	3.68	2228.18	30.66	1012.99
T_{14} (D_3 V_4)	12.67	14.27	0.77	39.00	6.86	3.75	2382.68	30.00	1053.59
T_{15} (D_3 V_5)	12.33	13.59	0.78	39.53	6.89	4.01	2311.18	30.67	1076.27
S.E(d) (±)	0.64	0.58	0.03	0.56	0.14	0.11	62.48	0.80	50.48
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Seed yield ($kgha^{-1}$): The highest seed yield of 1081.55 $kgha^{-1}$ was obtained from D_3 while the lowest seed yield (972.91 $kgha^{-1}$) was observed from D_1. The lower grain yield of mungbean in early planting might be due to lower temperature at early stages of crop growth. The increase in seed/grain yield in 15th March might be due to suitable temperature prevailing accompanied by the higher soil moisture content due to sufficient rainfall, which enhanced the vegetative as well as the reproductive growth of the crop. Similar results were also reported by Dhanjal *et al.* (2000) [5]. Higher seed yield of 1083.57 kg ha^{-1} was obtained from DGGS-4 variety and lowest seed yield of 988.84 kg ha^{-1} was obtained from HUM-2 variety. The difference in seed yield among genotypes may be due to differential behaviour of genotypes. The probable reason of this difference might be due to higher number of pod length, seeds per pod. Genotypic variation in seed yield was also observed by Patil *et al.* (2003) [12] and Kumar *et al.* (2009) [8].

Straw yield ($kgha^{-1}$): The highest straw yield of 2352.38 $kgha^{-1}$ was obtained from 15th March (D_3). While the lowest from 24th February (D_1) *i.e.* 2264.64 $kgha^{-1}$. The increase in straw yield was due to higher dry matter production which resulted in greater translocation of food materials to the reproductive parts. Similar results were also reported by Ram and Dixit (2000). Higher seed yield of 2390.17 kg ha^{-1} was obtained from DGGS-4 variety and lowest seed yield of 2210.41 kg ha^{-1} was obtained from HUM-2 variety. Variation in the stover yield is mainly governed by the genetic makeup of the respected variety and this variation among mungbean genotypes have been reported by many researchers (Miah *et al.*, 2009) [10], Rabbani *et al.* (2013) [13] and Parvez *et al.* (2013) [11].

Harvest Index: The harvest index of 30.87 was obtained from 15th March (D_3), i.e.30.3 and 29.47 was observed from 24th February (D_1) sowing date. The increased harvest index with late sowing could be related to high assimilate use efficiency due to increased sink capacity, together with favourable weather conditions which caused better growth of plants. This result agrees with the findings of Jahan and Adam (2012) [6] and Kumar *et al.* (2013) [7]. Highest harvest index was obtained from DGGS-4 variety, which was on par with HUM-16 variety (30.56). The increased harvest index in the genotypes might be owing to production of higher grain over its straw. Different mungbean genotypes exhibited great variations in the productivity parameters. The lowest harvest index of 29.78 was obtained from HUM-12 variety. The possible reason for lowest harvest index could be the fact that these failed to translocate the photosynthates to the grains However, these results differ with the findings of Sarkar *et al.* (2004) [16] and Rabbani *et al.* (2013) [13].

Conclusion

Plant growth is influenced by environmental conditions to a large extent. The effects of variation in weather conditions are truly reflected on the performance of the crop. From this study it can be concluded that plants sown on 15th march (D_3) grew well and gave a high yield as compared to the other dates of planting. Similarly, the variety HUM-16 (V_2) performed to be superior over other varieties under study. Thus, sowing of the proper variety at right time helped in matching the crop growth to favorable climatic conditions which produced best results in terms of plant growth and yield.

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