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Planting date effects on the incidence of mungbean yellow mosaic virus (MYMV) and cultivars performance under rainfed environments

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Abstract

Optimum planting date is an important factor for achieving improved mungbean production in different agro-ecological zones of the world. To determine the effects of different planting dates on the performance of mungbean cultivars under rainfed conditions, a split plot experiment consisting of eight planting dates (May 26th, June 2nd, 9th, 16th, 23rd, 30th and July 7th, 14th) and two cultivars (AZRI.M-2006 & NM-2006) was conducted during May-October 2011 and 2012 at Gram Breeding Research Substation, Kallurkot, Bhakkar, Pakistan. Results revealed a productivity difference of 1766 kg/ha between the best (June 2nd) and worst (July 14th) planting date. Maximum plant height, pods per plant, pod length, seeds per pod, 1000 grain weight, seed yield and fewer incidence of MYMV belonged to June 2nd planting followed by May 26th while beyond this, there was a gradual decrease in yield and relevant components and increase in MYMV incidence, being the highest on July 14th planted crop. Highest mean seed yield (1990 kg/ha) and lowest MYMV incidence were recorded from June 2nd sown experiments while lowest mean seed yield (224 kg/ha) and highest MYMV incidence were observed from July 14th sown trials. Mungbean sowing experiments conducted on June 2nd perhaps completed physiological phase's i.e. vegetative and reproductive at proper time which accounted for its higher yield than later or earlier sown trials. Lesser incidence of MYMV and shorter plant height of AZRI-M.2006 with greater pods per plant, pod length, 1000 grain weight contributed to its more seed yield than NM-2006. Further, correlation studies revealed positive and significant relationship of seed yield with plant height, pods per plant, pod length and seeds per pod while negative and significant with MYMV.

Keywords: mungbean; planting date; performance; MYMV; rainfed region.
Abbreviations: PH_Plant height, PPP_Pods per plant, PL_Pod length, SPP_Seeds per pod, TGW_1000 grain weight, MYMV_Mungbean yellow mosaic virus, SY_Seed yield.

Introduction

Greengram (*Vigna radiate* L.) commonly known as mungbean, is the second leading pulse crop in cereal based diet dependent many Asian countries. Its seed contains about 24.7% protein, 3.7% ash, 0.9% fiber and 0.6% fat, and is more palatable, nutritious and non-flatulent than other pulses (Malik et al., 2014). Shorter maturity period, lesser water requirement and soil improvement ability fits mungbean well in any intensive cropping pattern. In Pakistan, major contribution regarding mungbean area (83%) and production (88%) is shared by Punjab province where its cultivation is generally carried out in rainfed / arid zones of Thal region (Anonymous, 2012-13). Low production and preference of cash crops like cotton and wheat by the farmers are the causes responsible for ever reduction in area under pulse crops in the country. Various factors such as cultivation of locally available seed of unapproved mungbean genotypes at inappropriate time, inadequate plant protection measures and no or imbalance use of fertilizers are responsible for low yield at farmer's field. Among these causes, optimum sowing time and variety selection are of greater importance. Being a non-monetary input, sowing time is considered as one of the important productivity limiting factors that affect the plant growth and ultimately crop yield (Sadeghipour, 2008).

For improved mungbean production, optimum sowing time may vary from variety to variety and season to season due to variation in agro-ecological conditions as it determines the vegetative, reproductive and maturity periods (Soomro and Khan, 2003). Several research efforts on planting date effects on mungbean performance have already been done in different regions of the world, however little information is available regarding its effects under rainfed environments as moisture utilization at proper time is necessary for good crop production (Hussain et al. 2004; Miah et al. 2009). For improved mungbean production, determination of best planting time is inevitable as late sowing fetches lesser grain yield due to shorter growing season and resultantly lesser accumulation of photosynthates while early sowing invites a large number of insect pests (sucking and pod borer), and diseases like mungbean yellow mosaic virus (Khattak et al., 2008). MYMV is caused by mungbean yellow mosaic begomo virus belonging to family, Geminiviridae. This virus is transmitted by white fly (*Bemisia tabaci* Genn) through grafting but not through seed, sap and soil (Bashir 2003; Qazi et al., 2007). Initially, it appears as yellow spots on young leaves along the veins and then spread to the other leaves. Under severe infection, the entire leaf can show yellowing or

chlorosis on the whole plant followed by necrosis, shortening of internodes, severe stunting of plants with no yield or few flowers, and deformed pods producing small, immature and shriveled seeds (Akhtar and Haq 2003; Bashir et al., 2006).
Keeping in view the aforementioned facts, the present investigation was carried out to determine the effects of planting date on the performance of mungbean cultivars and incidence of MYMV under rainfed environments of Punjab, Pakistan.

Results and Discussion

Planting date effects on yield and relevant traits

Planting time in terms of altered temperature has been a considerable factor to get better crop yield in various crops including mungbean. The severe losses in seed yield have been observed with delay in planning time. Breeders are always involved to generate genetic diversity among existing germplasm through incorporation of new and novel genes through conventional and other breeding techniques. Mungbean is a self-pollinated crop, therefore there are enough possibilities to increase seed yield through developing new high yielding varieties along with adoption of appropriate package of production technology. Newly evolved promising mungbean cultivars were therefore evaluated to determine the effects of planting time on seed yield and other yield related traits.
Planting date effects on various mungbean response measurements are presented in figures 1 to 4. In the current study, seed yield difference of 1766 kg/ha was recorded between the best and poor yielding planting date. This difference in yield was mainly caused by increased frequency of mungbean yellow mosaic virus that drastically limited the plant growth and yield contributing parameters. Highest plant height (62.6 & 61.8 cm), pods per plant (39.1 & 38.6), pod length (8.7 & 8.4 cm), seeds per pod (9.4 & 9.0), 1000 grain weight (58.5 & 58.3 g), seed yield (1990 & 1740 kg/ha) and lowest MYMV incidence (0.5 & 0.9) belonged to 2nd and 1st planting dates i.e., June 2 and May 26 respectively. Being a warm season crop, the increase in mungbean seed yield and its components may be due to prevailing favorable temperature coupled with moisture availability from rainfall which resulted in suitable vegetative and reproductive plant growth phases so improvement in seed yield is rational. Beyond June 2 and May 26, there was considerable decrease in yield and yield related traits up to July 14th sown crop which attained the lowest plant height (58.9 cm), pods per plant (37.2), pod length (7.4 cm), seeds per pod (8.0), 1000 grain weight (56.7 g) and seed yield (224 kg/ha.). The main factor behind this reduction in mungbean response measurements was higher incidence of mungbean yellow mosaic virus (3). With delayed planting, the incidence of mungbean yellow mosaic virus has gradually increased that reduced the plant height, pods per plant, pod length, seeds per pod, 1000 grain weight and ultimately seed yield. Similar kind of substantial decrease in agronomic and yield traits was reported by Soomro and Khan (2003). Bell (2001) reported increase in vegetative dry matter with the delay in sowing. These findings of reduction in seed yield and related traits with delay in planting are in accordance to those obtained by Miah et al. (2009) and Siddique et al. (2006).

Variety effects on yield contributing traits

Both the varieties differed significantly to each other regarding seed yield and yield causative traits (Table 3). AZRI.M-2006 produced more seed yield in comparison to NM-2006 over all the planting dates. Relatively shorter plant height (58.7 cm), greater pods per plant (38.5), pod length (8.1 cm), 1000 grain weight (58.8 g) and lesser incidence of mungbean yellow mosaic virus (1.6) contributed significantly to the higher seed yield of AZRI.M-2006 (1120.6 kg/ha). On the other hand, NM-2006 attained more plant height (63.2 cm) and seeds per pod (8.8) but greater incidence of mungbean yellow mosaic virus (2.0) and lesser pods per plant (37.6), pod length (7.8 cm) and 1000 grain weight (56.2 g) resulted in its lower seed yield (1054.5 kg/ha). The differences in response measurements of both the varieties might be due to dissimilarity in their genetic makeup. These results are in accordance to those obtained by Siddique *et al*. (2006) and Patil *et al*. (2003).

Planting date × variety interaction effects on productivity

Interaction effects of different planting dates and mungbean varieties were found significant for all the response measurements (Table 4). Sowing of AZRI-M.2006 on June 2nd produced the highest seed yield (2085 kg/ha) mostly due to increased pods per plant (39.7), pod length (8.8 cm), seeds per pod (9.4), 1000 grain weight (60.1 g) and lesser incidence of MYMV (0.3). Planting of NM-2006 on July 14th fetched lowest seed yield (213 kg/ha) largely due to reduction in pods per plant, pod length, 1000 grain weight and increased incidence of MYMV. Minimum and maximum plant height (65.1 & 56.6 cm) belonged to July 14th sowing of AZRI-M.2006 (56.6 cm) and June 2nd planting of NM-2006 (65.1 cm) respectively. Highest pods per plant (39.7), pod length (8.8 cm), and 1000 grain weight (60.1 g) were produced by AZRI-M.2006 when cultivated on 2nd of June however regarding NM-2006, these measurements were found lowest (36.7; 7.2 cm & 55.6 g respectively) when the variety was planted on July 14th . Both AZRI-M.2006 and NM-2006 produced highest seeds per pod (9.4) when sown on June 2nd while July 14th planted AZRI-M.2006 yielded lowest seeds per pod (7.9). Incidence of mungbean yellow mosaic virus was least on June 2nd sowing of AZRI-M.2006 followed by May 26th of AZRI-M.2006 and June 2nd of NM-2006. Beyond June 2nd and May 26th planted mungbean experiments, there was subsequent increase in the attack of MYMV with every planting date and highest on July 14th planted NM-2006.

Relationship among studied plant traits

Information regarding correlation among various plant traits is useful for devising a constructive breeding programme to exploit the desirable genetic variations and to formulate an efficient selection program for the development of high yielding and well adapted genotypes. Selection based on yield components for improving seed yield in mungbean is well documented (Poehlman, 1991 and Singh et al. 1995). Correlation coefficients computed among various mungbean response measurements are given in Table 5. In the present studies, plant height was positively and significantly associated with seeds per pod and seed yield while significantly but negatively with 1000 grain weight. This indicates that increase in plant height has also increased seeds per pod and seed yield but decreased 1000 grain weight. These results are in agreement to those reported by Khan

Table 1. Some meteorological data during two years.

Month	2011			2012		
	Temperature (^{0}C)		Rainfall	Temperature (^{0}C)		Rainfall
	Min.	Max.	(mm)	Min.	Max.	(mm)
May	21.4	39.1	5.6	20.8	41.2	3.4
June	24.8	39.8	5.6	24.6	41.7	4.0
July	23.9	38.3	5.0	22.4	38.9	2.4
August	22.3	37.1	2.3	22.9	36.4	1.6
September	20.2	36.1	1.1	21.1	36.7	0.9
October	15.9	33.4	0.5	14.9	33.8	0.1
Average	21.4	37.3	3.4	21.1	38.1	2.1

Source: Gram Breeding Research Substation, Kallurkot, Pakistan.

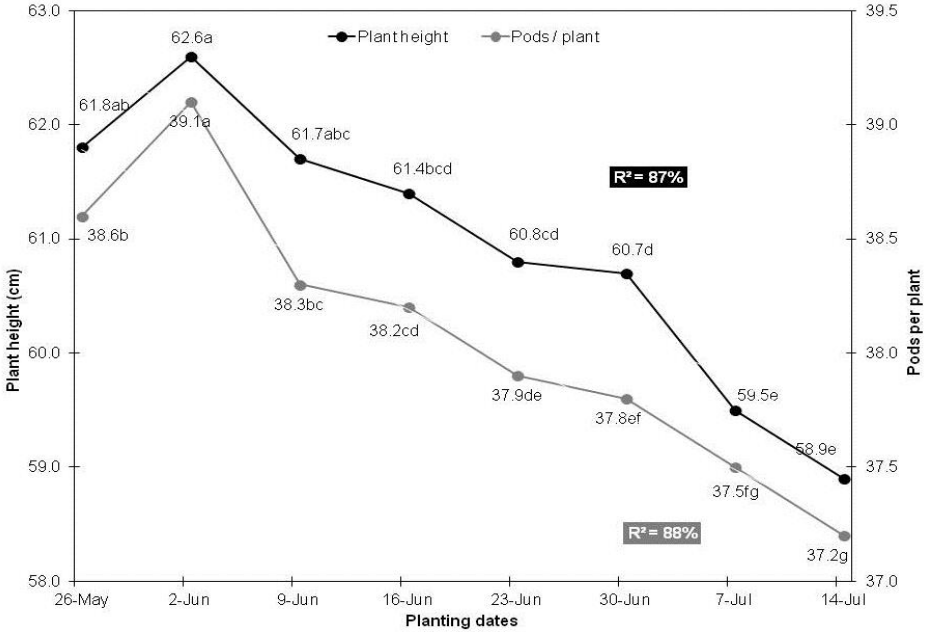

Fig 1. Planting date effects on plant height and pods per plant

(1988); Amanullah and Hatam (2000); Gul et al. (2008). Association of pods per plant with pod length, 1000 grain weight and seed yield was positive and significant similar to the results reported by Fransico and Maeda (1989); Naidu (1993); Gul et al. (2008). Significant and positive correlation was observed for pod length with seeds per pod, 1000 grain weight and seed yield comparable to the earlier reported studies of Hakim (2008). Relationship of seeds per pod with seed yield was found positive and significant. These findings are in accordance to the previous studies of Patil and Deshmukh (1988); Gul et al. (2008). Except with plant height, association of MYMV with all the studied traits i.e. pods per plant, pod length, seeds per pod, 1000 grain weight and seed yield was negative and significant. This suggests that increase in the incidence of MYMV will reduce pods per plant, pod length, seeds per pod, 1000 grain weight and ultimately seed yield. Correlation coefficients in the current study on planting dates indicated that traits like plant height, pods per plant, pod length, seeds per pod and MYMV incidence had more effect on mungbean seed yield.

Materials and Methods

Experimental site

The present field study was conducted during 2011 and 2012 kharif seasons (May-October) at Gram Breeding Research Substation (GBRSS), Kallurkot (latitude 32º 22' N & longitude 70º 47' E), Bhakkar, Punjab, Pakistan.

Soil properties

Prior to the field preparation, random soil sampling was done from several points of the field from the depth of 0 to 30 cm, and soil analysis was performed which revealed that soil texture was a sandy-loam with EC = 0.80 dsm^1, pH = 7.2, organic matter = 0.93%, soil nutrients, N = 0.29 ppm, P_2O_5 = 3.2 ppm, K_2O = 80 ppm, and saturation = 28%.

Layout design and treatments

The experimental design was split plot based on randomized complete blocks (R.C.B.) with two factors in four replications. Main plots included eight planting dates; May 26th, June 2nd, 9th, 16th, 23rd, 30th, and July 7th, and 14th while sub-plots comprised of two medium maturing cultivars; AZRI.M-2006 and NM-2006.

Plot size and production practices

Treatments were planted in a unit plot size of 4.8 m^2 by maintaining a distance of 30 cm between the rows, and 10 cm between plants in all the sowing date experiments. No insecticides or pesticides were sprayed during cropping

Table 2. Disease scale for rating of mungbean yellow mosaic virus (MYMV) Symptoms.

Symptoms	Rating/Disease severity	Disease index (%)	Disease reaction
Complete absence of symptoms	0	0	Immune*/Field immune
Few small yellow specks or spots on few leaves seen after careful observations	1	0.01-10	Highly resistant
Bright yellow specks or spots common on leaves, easily observed and some coalesced	2	10.01-25	Resistant
Mostly coalesced bright yellow specks or spots common on leaves, but no or minor reduction in yield	3	25.01-40	Tolerant
Plants showing coalesced bright yellow specks or spots on all leaves, with no or minor stunting and set fewer normal pods	4	40.01-60	Susceptible
Yellowing or chlorosis of all leaves on whole plant followed by necrosis, shortening of internode, severe stunting of plants with no yield or few flowers & deformed pods produced with small, immature and shriveled seeds	5	>60.01	Highly susceptible

Table 3. Mungbean cultivars mean response measurements during two years.

Treatments	PH	PPP	PL	SPP	TGW	MYMV	SY
AZRI.M-2006	58.7 b	38.5 a	8.1 a	8.6 b	58.8 a	1.6 b	1120.6 a
NM-2006	63.2 a	37.6 b	7.8 b	8.8 a	56.2 b	2.0 a	1054.5 b

Means with the different letters in each column have significant difference at the 5% level of probability

Table 4. Effects of planting date and variety interaction on mungbean response measurements during two years.

Interaction	PH	PPP	PL	SPP	TGW	MYMV	SY
AZRI-M.2006 × May-26	59.3 fgh	39.1 ab	8.5 ab	8.9 bcd	59.5 ab	0.8 gh	1810 b
AZRI-M.2006 × June-2	60.1 efg	39.7 a	8.8 a	9.4 ab	60.1 a	0.3 h	2085 a
AZRI-M.2006 × June-9	59.7 efg	38.8 abc	8.3 bc	8.7 cde	58.7 abc	1.0 fg	1507 d
AZRI-M.2006 × June-16	58.9 fghi	38.4 abcd	8.1 cde	8.8 cde	58.5 abcd	1.3 efg	1194 e
AZRI-M.2006 × June-23	59.2 fgh	38.5 abcd	8.0 cdef	8.4 efgh	59.4 ab	1.8 de	904 f
AZRI-M.2006 × June-30	58.5 ghi	38.1 bcde	7.9 defg	8.4 efgh	58.0 abcde	2.1 cd	822 fg
AZRI-M.2006 × July-7	57.3 hi	37.9 bcde	7.7 fgh	8.2 fgh	58.4 abcd	2.5 bc	408 h
AZRI-M.2006 × July-14	56.6 i	37.6 bcde	7.5 hij	7.9 h	57.9 bcde	2.9 ab	235 i
NM-2006 × May-26	64.3 ab	38.1 bcde	8.2 bcd	9.2 abc	57.1 cdef	1.0 fg	1670 c
NM-2006 × June-2	65.1 a	38.5 abcd	8.5 ab	9.4 a	56.9 cdef	0.8 gh	1896 b
NM-2006 × June-9	63.7 abc	37.9 bcde	8.0 cdef	8.9 bcd	56.8 cdef	1.5 ef	1471 d
NM-2006 × June-16	63.9 abc	37.9 bcde	8.0 defg	8.8 cde	56.4 def	2.3 cd	1150 e
NM-2006 × June-23	62.5 bcd	37.3 cde	7.8 efgh	8.8 cde	55.2 f	2.3 cd	866 f
NM-2006 × June-30	63.0 abcd	37.4 cde	7.6 ghi	8.6 def	56.2 ef	2.5 bc	749 g
NM-2006 × July-7	61.8 cde	37.0 de	7.4 ij	8.4 efg	55.3 f	2.6 abc	420 h
NM-2006 × July-14	61.1 def	36.7 e	7.2 j	8.1 gh	55.6 f	3.1 a	213 i

Means with the different letters in each column have significant difference at the 5% level of probability.

Table 5. Relationship among various mungbean response measurements during two years.

Traits	PPP	PL	SPP	TGW	MYMV	SY
PH	-0.10	0.14	0.35*	-0.30*	-0.16	0.26*
PPP		0.57*	0.13	0.29*	-0.30 *	0.34*
PL			0.53*	0.19*	-0.61*	0.67*
SPP				-0.12	-0.47 *	0.57*
TGW					-0.18*	0.17
MYMV						-0.83*

*; Significant at probability level of 5%

season against sucking pests especially white fly, a vector for Mungbean Yellow Mosaic Virus (MYMV) to record its incidence. NPK fertilizer was applied @ 23-57-0 kg/ha respectively, as basal dose during final land preparation. Normal agronomic and cultural production practices of hoeing and weeding were carried out as per recommendations and were kept uniform in all plots during the growing period of the crop. None of the irrigation was applied to mungbean crop during cropping season. Meteorological data regarding minimum and maximum temperature and total rainfall from sowing to harvest at the experimental site is presented in Table 1.

Observations measured

The observations recorded were plant height (cm), pods per plant, pod length (cm), seeds per pod, 1000 grains weight (g), incidence of mungbean yellow mosaic virus and grain yield (kg/ha).

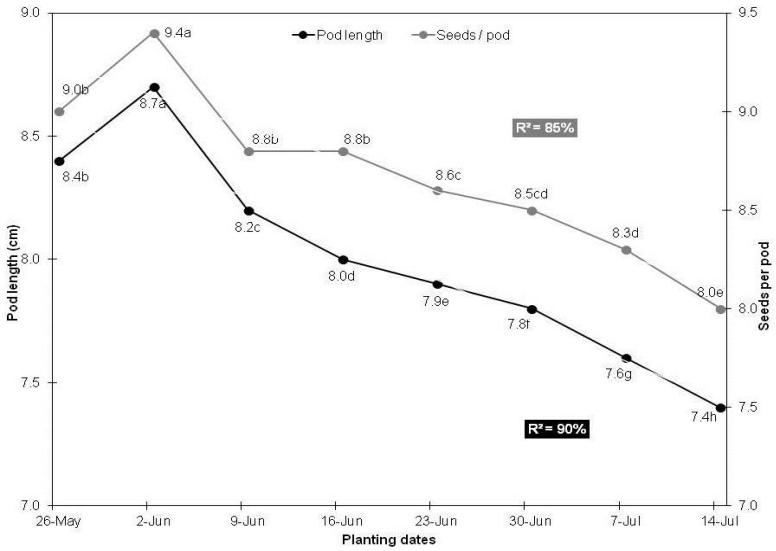

Fig 2. Planting date effects on pod length and seeds per pod.

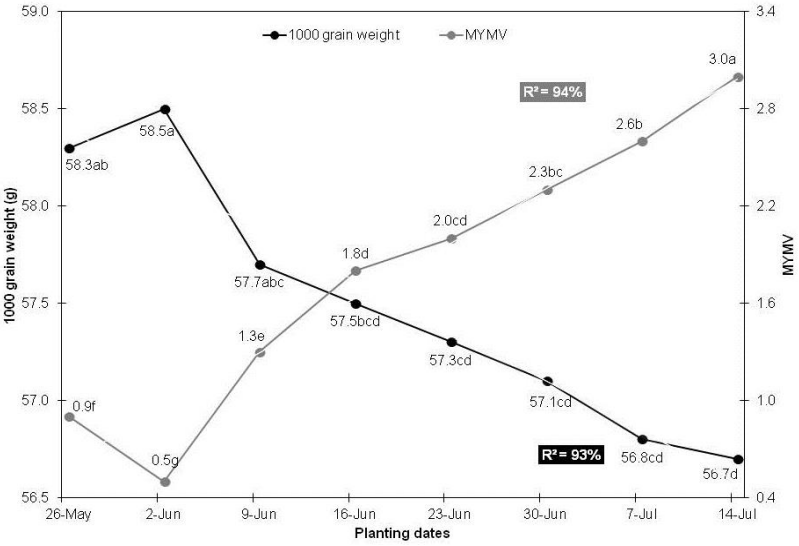

Fig 3. Planting date effects on 1000 grain weight and MYMV.

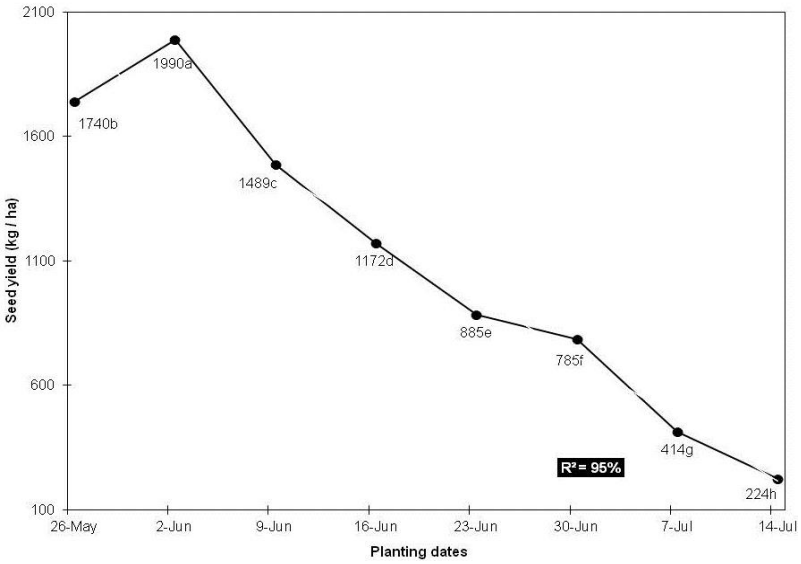

Fig 4. Planting date effects on seed yield.

Recording of morphological traits

Plant height and pods/plant were recorded on 10 randomly selected plants. Pod length and seeds/pod were recorded from 10 randomly selected pods within each genotype. 1000 grains were drawn from the dried bulk harvest (8% moisture) of each genotype and weighted (g). Harvested plants in the net plot were thrashed, dried and cleaned to record the yield which was then converted to kg/ha.

Recording of MYMV

Reaction of both the genotypes to MYMV and disease incidence (%) was determined according to the rating scale described by Akhtar et al. (2009). The percentage disease index was calculated by using the formula;

$$\text{MYMV disease index (\%)} = \frac{\text{Sum of all disease ratings}}{\text{Total \# of plants}} \times 20$$

Statistical analysis

Data recorded on all the observations were subjected to Fisher's technique of analysis of variance. Comparison of means for planting date and variety was done according to LSD test by MSTAT-C software (Steel et al. 1997). Effects of planting date on different mungbean response measurements were graphically presented using Microsoft PowerPoint. Linear correlation coefficients among different plant traits were calculated using SPSS software.

Conclusion

We can point that mugbean seed yield and its components were affected significantly by sowing dates. Sowing during 1st week of June increased yield relevant response measurements that contributed to greater mungbean productivity. Therefore, it is suggested that for good seed yield, planting of mungbean should be completed during last week of May to 1st week of June in arid zone and comparable environments everywhere.

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