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Effect of variety and planting dates on mungbean green pod and dry seed yields

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Abstract

In order to determine the impact of different planting dates on mungbean varieties as double purpose crop for vegetable and seed yields, field trials were conducted in clay soil in Qalubia governorate, during 2017 and 2018 summer seasons. Kawmy-1 and V2010 varieties were sown at 5 dates every two weeks namely, 15/5 (D1), 1/6 (D2), 15/6 (D3), 1/7 (D4) and 15/7 (D5). The results showed that Kawmy-1 surpassed V2010 in plant height, no. of pods palnt^{-1}, seed yield plant^{-1} as well as seed yield ha^{-1} in the 1st and 2nd harvests at 80 and 100 days after sowing respectively and total seed yield ha^{-1}. Regardless planting date Kawmy-1 was earlier in 50% flowering period and produced > 50% of sed yield plant^{-1} and seed yield ha^{-1} of the total seed yield at the 1st harvest (80 days after sowing) compared with V2010. The best seed yield ha^{-1} was attained at 15/5 and 1/6 planting dates (D1 and D2), and in the subsequent planting dates it reduced gradually in the later planting dates. The planting date 15/5 (D1) gave the highest seed yield ha^{-1} and surpassed D2 without significant differences among D2 and D3, D4 and D5 in the total seed yield ha^{-1}. The interaction between variety and planting date showed that Kawmy-1 was superior in seed yield ha^{-1} when it was sown either in D1 (15/5) or D2 (1/6) followed by V2010 when it was planted at D1. The results of mungbean as vegetable crop indicated that Kawmy-1 variety produced greater green pods yield than V2010. Gradual reductions in green pods yield as planting date retarded and the best green yield pods was reported at D1 planting date. Regarding the interaction effect between variety and planting date on green yield pods, the results showed that the best planting dates were D1 and D2 for both varieties to produce the greatest green pods yield. It could be concluded that mungbean could be used as double purpose crop ether for green pods or dry seed.

Key Words: *Mungbean, dual usage, Planting dates, temperature, Yield characteristics*

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Introduction

There is a shortage in edible summer legumes in Egypt. The introducing of high yielding food crops with short growing season in the crop pattern is an effective mean for narrowing the food gap in Egypt (Ashour *et al*., 1995). Mungbean or green gram (*Vigna radiata* (L.) Wilczek) is an early maturing high yielding pulse crop that widely spread and cultivated in the warmer regions of the world. It could be considered as seed, vegetable and forage crop according to its uses. It is a short duration (65 - 90 days) grain legume having wide adaptability and low input requirements (Nair *et al*., 2012). The cultivation of mungbean extends across wide regime of latitudes (40 N or S) in regions with diurnal temperatures of growing season are > 20 ºC (Lawn and Ahn, 1985). Mungbean has a distinct advantage of being short-duration and can grow in wide regime of soils and environments as mono or relay legume (Bindumadhava *et al.*, 2018). When the nutritive value of mungbean seeds is compared with other pulse crops cultivated in Egypt, it surpasses lentil and broad bean in Ca, Fe and vitamin A.

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The protein content is more or less the same for the three pulses (Ashour *et al.*, 1993). So, it is considered as poor men's protein (Mian, 1976). The mungbean productivity is very low in tropical and sub-tropical regions (Haider and Ahmed, 2014).

Although mungbean is a tropical crop and gives the best growth and seed yield in arid and semi-arid regions, heat limitation is undoubtedly a critical environmental constraint hampering the crop production. Among the various agronomic practices, planting time is the most important factor influencing the yield of mungbean (BARI, 1998). A significant effect of planting time on seed yield was found in mungbean (BARI, 1999). Sarkar *et al.* (2004) observed that early planted (3 and 18 February) crop produced higher yield as compared to late planted (5 and 20 March) crop. The characteristics of mungbean are affected by the variety used. Miah *et al.* (2009) identified the suitable variety and optimum sowing date for getting maximum yield of summer mungbean. They added that the interaction between variety and sowing date significantly influenced all the yield contributing characters (except 1000-seed weight) and yield of summer mungbean. Yield contributing characters like number of pods plant^{-1}, seeds pod^{-1} and seeds plant^{-1} contributed to the highest seed yield. Naveed *et al.* (2015) indicated that optimum planting date is an important factor for achieving improved mungbean production in different agro-ecological zones of the world. They evaluated the effects of different planting dates on the performance of mungbean cultivars and reported that maximum plant height, pods plant^{-1}, pod length, seeds pod^{-1}, 1000 grain weight, seed yield belonged to June 2nd planting followed by May 26th while beyond this, there was a gradual decrease in yield and relevant components. Begum *et al*. (2009) revealed that variety and seed rate had significant effect on the studied crop characters and yield. Zahan *et al*. (2016) concluded that variety and seed rate had significant effect on plant population of mungbean, number of pods plant^{-1}, pod length, number of seeds pod^{-1}, seed yield and stover yield.

Therefore, the aim of this work is to determine the impact of different planting dates on mungbean varieties as double purpose crop for vegetable and seed yields under Egyptian conditions.

Materials and Methods

In order to determine the proper heat regime for growing mungbean as a new crop under Egyptian conditions during the summer season, field experiments were conducted in clay soil in Qalubia Governorate, in 2017 and 2018 summer seasons. The experimental soil was clay in texture with pH 7.8, OM 1.28 %, N 0.47 %, P 0.48 % and K 0.27 %. Kawmy-1 and V2010 varieties were sown at 5 dates every two weeks namely, 15/5 (D1), 1/6 (D2), 15/6 (D3), 1/7 (D4) and 15/7 (D5). The mean minimum and maximum temperatures during each planting date in both seasons were (17.0 – 27.0), (19.5 - 31.5), (23.0 - 36.5), (23.5 - 37.5) and (25.0 - 38.0) for D1, D2, D3, D4 and D5, respectively.

The soil was ploughed twice, ridged and divided into experimental plots. The experimental design was split plot with 6 replicates; the planting dates occupied the main plots and each two sub plots were assigned to the varieties, the plot area was 21 m^2 and each contained 5 rows 6 meter long and the distance between rows 0.7 m. Mungbean seeds were sown in hills 10 cm apart by the afeer method (dry soil) at the experimented planting dates. After complete germination, the plants were thinned and one healthy plant per hill was left to grow. During seed bed preparation, calcium super phosphate (15.5%) was applied at the rate of 37 kg P_2O_5 ha^{-1}and potassium sulfate (48 % K_2O) was applied at the rate of 115 kg K_2O ha^{-1}. Before the 1st irrigation, nitrogen fertilizer as ammonium sulphate (20.6 % N) was applied at the rate of 72 kg nitrogen ha^{-1}. Irrigation was applied according to the recommended practice for irrigation in the district. The experimental plots were arranged in a split plot with 4 replicates; each 5 plots which assigned to a planting date and was sown on the planned time. During the growing season two ridges were labeled and the number of days to 50 % flowering was recorded. Harvest was carried out twice after 80 and 100 days from sowing. At the second harvest, four guarded hills (10 plants) were labeled and the following parameters were registered:

1- Plant height (cm).
2- Number of branches plant^{-1}.

Yield components characters:

3- Number of pods plant^{-1} at 80 and 100 days from sowing and total No. of pods plant^{-1}.
4- 1000-seeds weight (g).
5- Seed yield per plant (g) at 80 and 100 days from sowing and total seed yield plant^{-1}.
6- Harvest index.
7-Seed yield ha^{-1}.

Green pods yield ha^{-1}:

It was determined by counting the green pods formed at 80 days to calculate the percentage of green pods to the total number of pods formed and thereafter the green pods were collected, and weighed to determine yield per hectare. Two ridges were devoted for pod collecting twice at 80 and 100 days to determine seed yield per hectare in each of the two harvest times and the total seed yield (kg ha^{-1}). In order to determine the actual reduction of seed yields per plant and per hectare due to planting date and variety the difference in optimum minimum and maximum temperature from the best planting date reported was calculated, then the reduction in these criteria were determined.

The analysis of variance of split plot experiment was carried out using MSTAT-C Computer Software (MSTAT-C, 1988), after testing the

homogeneity of the error according to Bartlett's test, combined analysis for both seasons were done. Means of the different treatments were compared using the least Duncan's Multiple Range Test at 0.05 level.

Results and Discussion

Effect of variety:

Data presented in Table (1) show the superiority of Kawmy-1 than V2010 in plant height, No. of pods palnt^{-1}, seed yield plant^{-1} and seed yield ha^{-1} in the 1st and 2nd harvests at 80 and 100 days after sowing, respectively and total seed yield ha^{-1}. However, V2010 exceeded Kawmy-1 in seed index. Regardless planting date Kawmy-1 flowered earlier and produced > 50% of seed yield plant^{-1} and seed yield ha^{-1} of the total seed yield at the 1st harvest (80 days after sowing) compared with V2010. The results of using mungbean as vegetable crop indicated that Kawmy-1 variety produced greater green pods yield than V2010 although V2010 possessed greater green pods percentage than Kawmy-1; this may be due to the greater number of pods formed by Kawmy-1 (nearly double) than that of V2010. The obtained results are in harmony with those obtained by Abd El Lateef *et al*. (1998) who found that different mungbean accessions gave their first flower after a period of 43 to 45 days and from 44.3 to 46.3 in two successive seasons. Shalaby *et al*. (1991) found that different mungbean accessions gave their first flower after a period of 45 to 55 days and from 44.3 to 56.3 in two successive seasons in upper Egypt. Also, these results are in accordance with the results obtained by other researchers for most of the legumes (Mahmood-ul-Hassan *et al*., 2003; Achakzai and Kayani, 2004; Malik *et al*., 2006 and Siddique *et al*., 2006).

Table 1: Effect of mungbean variety on vegetative growth and yield characteristics

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Variety	No. of days to 50% Flowering	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}			Green pod %	Green pod yield (kg ha^{-1})	Seed yield g plant^{-1}			Seed index (g)	Seed yield (kg ha^{-1})		
				80 days	100 days	Total			80 days	100 days	Total		80 days	100 days	Total
V2010	42.7 a	80.3 a	5.7 a	13.2 b	9.9 b	23.1 b	0.43 a	790 b	6.1 b	5.8 b	11.9 b	67.7 a	1092 b	751 b	1843 b
Kawmy-1	41.8 a	87.3 a	5.6 a	25.8 a	16.5 a	42.3 a	0.39 a	1055 a	8.9 a	7.7 a	16.6 a	46.3 b	1459 a	1245 a	2704 a

Effect of planting date:

Data in Table (2) show that planting date had significant effects on plant height, number of pods plant^{-1}, seed yield plant^{-1} and seed yield ha^{-1} at 80 and 100 days from sowing. Generally, the data reveal that there were not significant effects in flowering until 1/7 planting date (D4) thereafter, the flowering duration was significantly shortened. Plant height was not affected till 1/6 planting date (D2), then it was gradually declined. Seed index was significantly affected by the different plant dates and the best seed index was obtained at 15/5 (D1) planting date. Regarding seed yield plant^{-1}, it can be noticed that it was not affected until 15/6 planting date (D3) at the 1st harvest after 80 days from sowing and till 1/6 planting date (D2) at the 2nd harvest after 100 days from sowing, then gradual reductions in seed yield plant^{-1} were reported. The best seed yield was attained at 15/5 and 1/6 planting dates (D1 and D2), but it reduced gradually in the later planting dates. Concerning the total seed yield ha^{-1}, it is clear that planting date 15/5 (D1) gave the highest seed yield and surpassed D2 meanwhile the differences among D2 and D3, D4 and D5 in the total seed yield ha^{-1} were insignificant. From the same table it is clear that there were gradual reductions in green pods yield as planting date retarded and the best green yield pods was reported at D1 planting date. The reported green pods yield for the first and second planting dates (D1 and D2) was more than one t ha^{-1} with significant difference between the two dates (Figure 1). In this respect Naveed *et al*. (2015) indicated that maximum plant height, pods per plant, pod length, seeds per pod, 1000 grain weight, seed yield belonged to June 2nd planting followed by May 26th while beyond this, there was a gradual decrease in yield and relevant components.

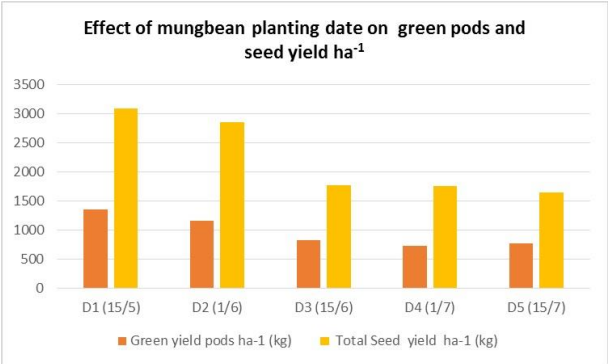

Figure 1: Effect of mungbean planting date on green pods and seed yield ha^{-1}

Table 2: Effect of mungbean planting date on vegetative growth and yield characteristics.

Planting date	No. of days to 50% flowering	Plant height (cm)	No. of branches plant^{-1}	No. pods plant^{-1}			Green pods %	Green yield pods ha^{-1} (kg)	Seed yield plant^{-1} (g)			Seed index (g)	Seed yield ha^{-1} (kg)		
				80 days	100 days	Total			80 days	100 days	Total		80 days	100 days	Total
D1 (15/5)	43.9 a	95.4 a	5.5 b	22.8 a	17.8 a	40.6 a	41 c	1355 a	8.7 a	7.9 a	16.6 a	60.8 a	1819 a	1272 a	3091 a
D2 (1/6)	44.1 a	90.6 a	5.3 b	18.4 b	12.6 c	31.0 b	46 ab	1161 b	8.0 a	7.7 a	15.7 a	56.7 b	1678 a	1178 ab	2856 a
D3 (15/6)	42.1 ab	76.6 b	7.5 a	18.2 b	15.6 b	33.8 b	41 c	816 c	8.3 a	6.9 a	15.2 a	57.5 b	1102 bc	667 c	1769 b
D4 (1/7)	41.7 ab	78.3 b	5.3 b	22.8 a	16.0 a	38.8 a	47 a	725 c	6.8 b	5.6 b	12.4 b	55.3 bc	816 c	943 bc	1759 b
D5 (15/7)	39.8 b	80.0 b	5.0 b	20.3 b	17.7 a	38.0 a	44 b	764 c	5.7 b	5.7 b	11.4 b	54.6 c	826 c	814 c	1639 c

Effect of the interaction (Variety x Planting date):

The interaction between variety and planting date on number of pods per plant at the 1st and 2nd harvest (80 and 100 days after sowing), seed index as well as seed yield ha^{-1} was significant (Table, 3). In general, Kawmy-1 was superior in seed yield ha^{-1} when it was sown either in D1 (15/5) or D2 (1/6) followed by V2010 when it was planted at D1 (15/5). Regarding the interaction effect between variety and planting date on green yield of pods, the results showed that the best planting dates were D1 and D2 for both varieties to produce the greatest green pods yield. Kawmy-1 produced the highest green yield of pods in the 1st and 2nd planting dates followed by V2010 in the same planting dated with significant difference.

Similar results on the interaction between variety and planting date were reported by Sarkar *et al*., 2004, they observed that early planted (3 and 18 February) mungbean produced higher yield as compared to late planted (5 and 20 March) mungbean. Also, Miah *et al.* (2009) confirmed that there is interaction between variety and sowing date significantly influenced all the yield contributing characters (except 1000-seed weight) and yield of summer mungbean. Yield contributing characters like number of pods per plant, seeds per pod and seeds per plant contributed to the highest seed yield.

Table 3: Effect of the interaction between variety and planting date on mungbean yield characteristics.

Treatment					No. pods plant^{-1}					Seed yield plant^{-1} (g)				Seed yield ha^{-1} (kg)		
Variety	Planting date	Flowering %	Plant height (cm)	No. of branches plant^{-1}	80 days	100 days	Total	Green Pods %	Green yield pods ha^{-1} (kg)	80 days	100 days	Total	Seed index (g)	80 days	100 days	Total
V2010	D1 (15/5)	44.1 a	92 b	5.5 b	12.5 c	9.9 de	22.4 f	44.2 b	1173 bc	7.6 bc	6.8 b	14.4 b	69.9a	1643 b	1012 bc	2655 b
	D2 (1/6)	45.3 a	85 c	5.0 b	10.2 c	8.3 e	18.6 g	44.9 b	1018 c	6.5 c	7.4 ab	13.9 b	68.8a	128 4 c	986 c	2270 b
	D3 (15/6)	42.7 b	72 e	7.9 a	10.8 c	8.8 e	19.6 fg	44.9 b	668 d	6.4 c	6.1 b	12.5 c	68.2a	882 e	606 d	1488 d
	D4 (1/7)	41.4 b	73 e	5.5 b	14.3c	11.5 d	25.8 e	44.6 b	648 d	5.2 cd	4.5 c	9.7 d	66.3a	941 d	512 e	1453 d
	D5 (15/7)	40.2c	80 d	4.5 c	18.0 bc	11.0 d	29.0 e	37.9 c	518 e	4.9 d	4.3 c	9.2 d	65.4a	718 f	648 d	1366 e
Kawmy-1	D1 (15/5)	43.6 a	99 a	5.4 b	23.0 b	20.0 b	43.0 d	46.5 b	1728 a	9.8 a	9.0 a	18.8 a	51.7b	1993 a	1722 a	3715 a
	D2 (1/6)	42.8 a	95 ab	5.5 b	26.5 ab	16.8 c	43.3 cd	38.8 c	1336 b	9.5 a	8.0 a	17.5 a	44.6c	2070 a	1372 b	3442 a
	D3 (15/6)	41.5 b	81 d	7.0 a	25.5 ab	22.3 ab	47.8 b	46.7 b	1089 c	10.2 a	7.7 a	17.9 a	46.8 c	1321 c	1014 b	2335 b
	D4 (1/7)	41.9 b	81 d	5.0 b	31.3 a	20.4 b	51.7 a	39.5 c	833 d	8.4 b	6.7 b	15.1 b	44.5c	977 d	1135 b	2112 b
	D5 (15/7)	39.4 c	80 d	5.0 b	22.5 b	23.8 a	46.2 bc	51.4 a	984 d	6.5cd	7.0 a	13.5 bc	43.7c	932 de	982 c	1914 c

Data in Table (4) reveal that except the latest planting dates D4 and D5 for Kawmy-1, both varieties out yield more than 50% of the total seed yield at the 1st harvest (80 days after sowing). V2010 seems to be slight earlier in maturing than Kawmy-1 in D1. The data indicate that although Kawmy-1 yielded green pods and seed yield more than V2010 in D4 and D5 the earliness % was lower due to the high yielding ability of Kawmy-1 (Figure 2). These reductions in seed yield represented 14.5, 43.9, 45.2 and 48.5 for V2010 and 7.3, 37.1, 43.1 and 48.2 for Kawmy-1 in D2, D3, D4 and D5, respectively as compared with the best planting date (D1). While the corresponding values for green pods reduction were 10.4, 43.0, 44.8 and 55.8 for V2010 and 22.7, 36.9, 51.8 and 43.0% for Kawmy-1 in D2, D3, D4 and D5, respectively as compared with the best planting date. The reduction in seed yield and green pods due to the affected planting dates could be attributed to heat stress effects and it was reported that heat stress has a harmful effect at several levels of plant functions, leading to a drastic reduction in growth rates and yield traits (Wahid *et al*., 2007). Photosynthetic mechanism is recognized to be sensitive to elevated temperatures and may be inhibited as a result of loss of chlorophyll and reduced carbon fixation and assimilation (Sinsawat *et al*., 2004). Naveed *et al*. (2015) indicated that optimum planting date is an important factor for achieving improved mungbean production in different agro-ecological zones of the world, they evaluated the effects of different planting dates on the performance of mungbean cultivars under rainfed conditions. They added that maximum plant height, pods per plant, pod length, seeds per pod, 1000 grain weight, seed yield belonged to June 2nd planting followed by May 26th while beyond this, there was a gradual decrease in yield and relevant components. Also, the effects of elevated heat in the later planting dates was interpreted by similar work of Chikukura *et al*. (2017), they reported that elevated temperatures > 44/34 °C significantly affected net photosynthesis at all stages.

Table 4: Effect of variety and planting date on mungbean seed yield reduction.

Treatment		Seed yield kg ha^{-1}			Seed yield reduction	Green pod yield reduction
Variety	Planting date	80 days	100 days	Total		
V2010	D1 (15/5)	1643 b	1012 bc	2655 b	--	--
	D2 (1/6)	1284 c	986 c	2270 b	384	155
	D3 (15/6)	882 e	606 d	1488 d	1166	505
	D4 (1/7)	941 d	512 e	1453 d	1201	526
	D5 (15/7)	718 f	648 d	1366 e	1289	655
Kawmy-1	D1 (15/5)	1993 a	1722 a	3715 a	--	--
	D2 (1/6)	2070 a	1372 b	3442 a	273	392
	D3 (15/6)	1321 c	1014 b	2335 b	1380	639
	D4 (1/7)	977 d	1135 b	2112 b	1603	895
	D5 (15/7)	932 de	982 c	1914 c	1798	744

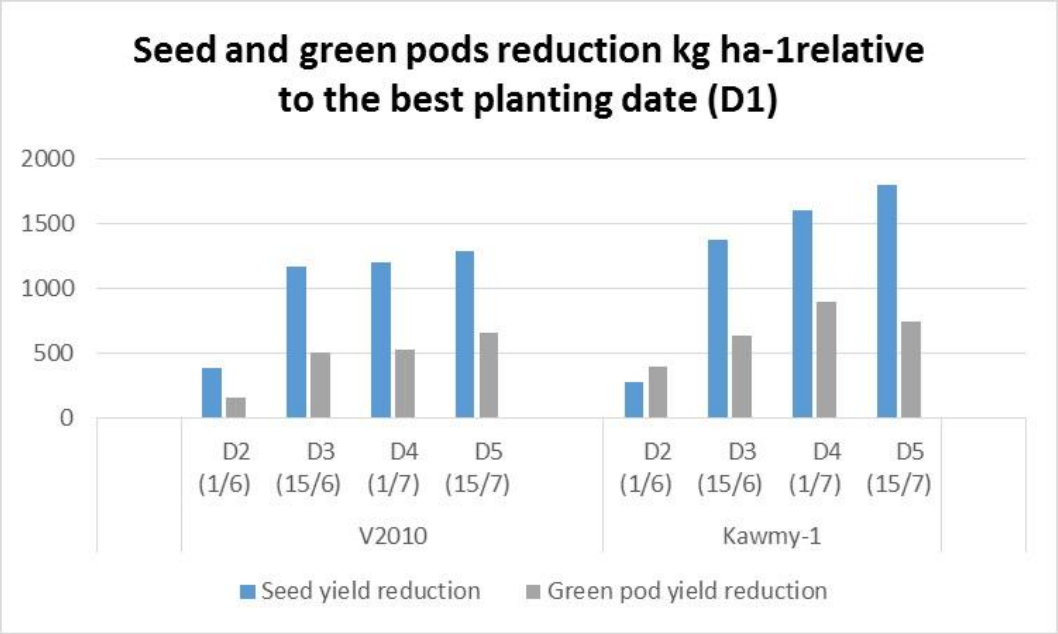

Figure 2: Seed yield reduction of mungbean varieties relative to D1 (15/5) planting date.

Conclusion

It could be concluded that mungbean could be used as double purpose crop either for green pods or dry seed which permits this crop to expand its uses under Egyptian conditions. The results emphasized that mungbean is among the most temperature sensitive crops and production could fluctuate with a slight change in temperature due to planting dates which was more pronounced from the lower yields in the later planting dates compared with the best planting date D1(15/5).

Author contribution statement

Ezzat ABD EL LATEEF, Ahmed EATA, Mostafa ABD EL-SALAM: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Competing interest statement

The authors declare no conflict of interest.

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