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ORIGINAL ARTICLES

Potentiality of using mungbean as a summer legume forage crop under Egyptian condition

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ABSTRACT

In order to evaluate mungbean as a multi-cutting forage crop an evaluation of the productivity and quality of six mungbean varieties were conducted. Two field experiments were carried out at a privet farm at Shalakan, Kalubia Governorate, Egypt, during summer seasons 2011 and 2012. The results revealed that, the varieties differed significantly from one to another regard to number of plants m^{-2}, plant height (cm), number of branches $plant^{-1}$ and leaf-to-stem ratio, fresh yield (ton/fed.), dry yield (ton/fed.), protein yield (kg/fed.), total digestible nutrients (TDN) yield (ton/fed.), content of crude protein (CP), crude fiber (CF), ash, ether extract (EE) nitrogen free extract (NFE) and total digestible nutrients (TDN). Mungbean cv. King excelled all other varieties in all characters except number of plants m^{-2}, crude fiber (CF), and nitrogen free extract (NFE). It can be deduced from this study that King variety is the best cultivar for forage yield and quality. Mungbean cvs. King, Kawmy-1 and VC1000 were found superior than other varieties in total fresh and dry forage yields as well as total protein and total digestible nutrients yields and these varieties can successfully be grown as fodder production with good quality. It could be concluded from this study that the promising multi-cutting mungbean varieties with the high nutritive value could effectively be employed to narrow the summer green forage gape and overcome the critical forage shortage period in Egypt.

Key words: *Vigna radiata*; Varieties; Growth characters; Forage yield; Forage quality.

Introduction

Forage crops production is very important for successful animal production, forage quality plays an important role in the feeding of dairy animals. In Egypt there is a shortage in green forage supply during the summer season because summer fodder crops occupy less than 7% of the total acreage of summer crops. Summer fodder crops could hardly find a place in the common cropping structure because of the strong competition from food and industrial crops. In summer season farmers depend on cereals as forage crops, especially fodder maize (*Zea mays* L.), which occupies about 85% of the total area devoted to summer fodder crops. Cereals as roughage have important potential in terms of yield, but quality (content of curd protein about 5-10%) and mineral contents is low in animal feeding (Abd El-Salam, 2002; Kumar *et al*., 2005; Abd El-Salam *et al*., 2008 and Abd El-Salam and El-Habbasha, 2008). Legume fodder is important for livestock production because it is rich in protein, minerals, phosphorus, calcium and vitamins (Bogdan, 1977 and Unkovich *et al*., 1997). Thus, milk animals fed cereals require a green legume crop to cover up the balance of their protein requirement. Mungbean (*Vigna radiata* L. Wilczek) also called green gram, it is an important summer annual leafy legume crop grown widely in South East Asia. It is a short duration (60-90 days) crop that can be grown twice a year *i.e*. in spring and autumn. Therefore, has less water requirement as compared to other summer crops. Moreover, it is drought tolerant that can withstand adverse environmental conditions and hence successfully be grown in rain fed areas (Anjum *et al*., 2006). It has the potential to enrich soil through atmospheric nitrogen fixation (Agboola and Fayemi, 1972; Sekhon *et al*., 2007 and Rana *et al*., 2011), it fixes atmospheric nitrogen at 50-100 kg ha^{-1} annually (Phoomthiasong *et al*., 2003). It is used as green manure, cover crop and as fodder in cut-and-carry system and as a concentrate feed. Although mungbean is grown mostly for grain production, it can be used as a double purpose (forage and seed) crop (El-Karmany *et al*., 2005 and El-Karamany, 2006). It can be incorporated into cereal cropping systems as a legume ley to address soil fertility decline and is used as an intercrop species with maize to provide better legume/grass feed quality (Abd El-Salam *et al*., 2008 and Abd El-Salam and El-Habbasha, 2008). Mungbean can be used as green forage for livestock may give farmers a chance to improve the quantity and quality of forage available for clipping or grazing. This crop can be successfully grown under Egyptian condition during summer season (Ashour *et al*., 1993). Mungbean can be grazed six weeks after planting and two grazings are usually obtained (FAO, 2012).

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Mungbean as a forage is rich in protein content, being about 16-18% on the dry matter basis (Twidwell *et al*., 1992; Attia-Ismail and Afiah, 1998; El-Karmany *et al*., 2005; Chumpawadee *et al*., 2007; Abd El-Salam *et al.*, 2008 and Abd El-Salam and El-Habbasha, 2008). Mungbean, like other fodders such as berseam and alfalfa is highly palatable legume attracted by the livestock and even more nutritious in nature (Boe *et al*., 1991 and Hediat-Ullah *et al*., 2012).

Limited research is available on the potential benefits of mungbean as dual or multi-cuttings forage crop. Most of the work of mungbean as forge crop focused on using it as double purpose (forage + seeds) crop (El-Karmany *et al*., 2005 and El- Karamany, 2006), or late sowing it as cover crop (Hozayn *et al*., 2007) or grazing (FAO, 2012). Therefore, the present experiment was conducted in order to identify mungbean varieties as multi cuttings forage crop which can provide a high amount of biomass with good quality.

Materials and Methods

Two field experiments were conducted during 2011 and 2012 summer seasons at a private farm at Shalakan, Kalubia Governorate, Egypt. The aim of this study was to evaluate the productivity and quality of sex varieties of mungbean including a check, mungbean (*Vigna radiata* L. Wilczek) varieties *viz*, King (imported from Australia), V2010, VC1000, VC21, VC15 (imported from Asian Vegetable Research and Development Centre; AVRDC, Taiwan) and a local Kawmy-1 as a check are used in both experiments. The soil was clay in texture (14.4 % sand, 32.6 % silt and 53.0 % clay) with pH of 7.88; 2.11% organic matter; 1.95 % $CaCo_3$; EC 1.29 mmhos/cm^2 and having 41.8, 19.8 and 225 ppm available N, P and K, respectively (average of the two seasons for the upper layer of 30 cm soil depth). The preceding crop was Egyptian clover (berseem) in both seasons. The experimental soil was ploughed twice using a chisel plow, and divided into experimental units each of 10.5 m^2 area (1/400 fed). A uniform basal dressing of phosphate fertilizer as calcium super phosphate 15.5% P_2O_5 at the rate of 150 kg/fed, was applied during seed-bed preparation. The experimental design was complete randomized block with four replicates. The study included 6 treatments which were varieties.

Mungbean seeds were inoculated with the specific strain of Rhizobium (*Bradyrhizobium* spp.) and immediately sown broadcasting in experimental units using seed rate of 25 kg/fed for each variety, sowing date was on May 10 and 15 in 2011 and 2012 seasons, respectively using dry method of sowing. A starter dose of N in the form of ammonium nitrate (33.5 % N), at the rate of 30 kg/fed was applied before the first irrigation (15 days from sowing). Another dose of similar amounts was also applied after first cutting (60 days from sowing).

Other recommended agronomic practices were followed. The first cut was taken after 60 days from sowing and the second cut was taken after 45 days from the first cut. Number of plants m^{-2} were determined. Ten plants were selected at random in each plot at the time of harvest and the parameters studied were: plant height, number of branches plant^{-1} and leaf-to-stem ratio. Whole plants in plots were harvested approximately at 10-15 cm stubble height above ground for computing fresh yield. A 500 g sub-sample was oven dried at 60° C for 48 hours to determine percentage dry matter and hence dry matter yield. The oven-dried material was ground to pass 1 mm screen in a Thomas-Wiley mill for use in chemical analysis. Kjeldahl N content was determined using the macro-kjeldhal according to (A.O.A.C., 1990). Crude protein (CP) content was then calculated by multiplying the kjeldahl N by 6.25 and crude protein yield, crude fiber (CF), ash, and ether extract (EE) contents were obtained from two replications. The chemical analysis followed the conventional methods recommended by A.O.A.C. (1990). The other forage quality characters were calculated as follows. Nitrogen free extract (NFE %) = 100 – (CP % + CF % + EE % + Ash %). Total digestible nutrients (TDN %): estimated according to Adams *et al*. (1964). TDN % for legume =74.43 + 0.35 CP % - 0.73 CF %. TDN % was multiplied by the dry forage yield to calculate total digestible nutrients yields.

The data were subjected to the proper statistical analysis as described by Gomez and Gomez (1984) since the data in both seasons took similar trends, Bartlett's test was applied and the combined analysis of the data was done for means comparison. Duncan's multiple range test was applied at 0.05 probability level to compare mean varieties.

Results and Discussion

Growth characters:

Number of plants m^{-2}:

An optimum plant population is considered to be the major component for having optimum yield. The results regarding number of plants/m^2 obtained at harvest are presented in Table (1), which shows that plant population was significantly affected by varying varieties. Mungbean cvs. Kawmy-1 and VC1000 gave the maximum plant population per unit area (61.5-60.3) in the first cut and (59.3-58.3) in the second cut, respectively, followed by variety King (55-51). The lowest plant population was recorded in variety VC15 (53-

46.3) in the first and second cuts, respectively. These significant differences among varieties may be due to the variation in seed size.

Plant height (cm):

Environmental factors and genetic characteristics of plants play an important role in determining the plant height. Plant height gets prime importance while determining the fodder yield. Significant differences were observed in plant height of different mungbean varieties, however King variety produced the tallest plants (98.2-64.5 cm.) followed by variety V2010 (90.9-57.2 cm) in the first and second cuts, respectively. The shortest plant was recorded by VC15 variety (78.4-49.8 cm) in the first and second cuts, respectively. The greater the plant height, led to the greater the fodder yield per unit area. Podriguez (1973) also reported that plant height was significantly correlated with yield and leaf-stem ratio. These significant differences might have been due to differences in genetic make-up of the varieties and competition between the plants for light. Also, some investigators indicate that such increase in plant height match to the severe competition between the plants to etiolate to reach and capture light but this assumption did not confirmed by the data of dry matter where King variety (the tallest one) produced the greater dry matter. These results are in agreement to those of Azmi *et al*. (1990) and Ashmawwy and Ezzat (1999) they found significant variation in plant height.

Table 1: Growth characters of six mungbean varieties at the first and second cuts (average of two seasons 2011-2012).

Variety	No. of plants m^{-2}		Plant height (cm)		No. of branches $plant^{-1}$		Leaf/stem ratio (wt.)	
	1st Cut	2nd Cut	2nd Cut	2nd Cut	1st Cut	2nd Cut	1st Cut	2nd Cut
King	55.0 b	51.0 b	98.2 a	64.5 a	3.6 ab	2.5 c	1.13 a	0.97 a
V2010	53.0 c	46.3 c	90.9 b	57.2 c	3.3 b	2.6 bc	1.10 a	0.95 a
VC15	52.8 c	43.3 d	78.4 d	49.8 d	3.9 a	3.8 a	1.02 b	0.96 a
VC20	52.5 c	50.5 b	85.9 c	54.3 c	3.2 b	2.9 b	1.03 b	0.97 a
VC1000	60.3 a	58.3 a	87.2 bc	60.6 bc	2.7 c	2.3 c	0.99 c	0.91 b
Kawmy-1	61.5 a	59.3 a	85.4 c	62.3 ab	2.8 c	2.4 c	0.99 c	0.92 b

In this table and following one, means followed by the same letter(s) are not significantly different according to Duncan's multiply range test.

Number of branches $plant^{-1}$:

The data in Table (1) revealed that the number of branches $plant^{-1}$. VC15 variety produced the maximum branches (3.9-3.8) and the minimum number of branches $plant^{-1}$ (2.7- 2.3) was recorded from the variety VC1000 in the first and second cuts, respectively. In addition, it is worthy to notice that cutting mungbean did not enhance growth to form greater number of branches compared to the first growth period (60 days). These results are in agreement to those of Azmi *et al*. (1990) and Ashmawwy and Ezzat (1999) they found significant differences among varieties in number of branches $plant^{-1}$.

Leaf/stem ratio (wt.):

This character plays a vital role in enhancing forage quality and increases the palatability to the animals. Data presented in Table (1) indicate slightly significant differences in leaf-to-stem ratio among varieties. Highest leaf-to-stem ratio was recorded in variety King (1.13) whereas lowest (0.91) was recorded by the variety VC1000. Also, it could be concluded that leaf-to-stem ratio declined from the first cut to the second cut. It seems that this character is related to the greater plant height and branching ability. Similar results were obtained by Boe *et al*. (1991) and Sharawy and El-Fiky (2003).

Forage yield:

Data given in Table (2) show the effect of six mungbean varieties on both fresh and dry forage yields as well as protein and total digestible nutrients yields. King variety tended to produce the highest amount of both fresh and dry forage yields as well as the highest amount of both protein and total digestible nutrients yields followed by Kawmy-1 and VC1000 varieties. The lowest green fodder and dry yields were recorded in variety VC15. King variety produced more green fodder yields ton fed^{-1}, than the other varieties because of contribution of more plant height, number of branches per plant and number of leaves per plant which in turn increased the green fodder yield. These differences among the cultivars were attributed to variability in their yield components. These findings are in conformity with those of El-Karamany *et al.* (2001); El-Karamany *et al.* (2003); Imran *et al.* (2007) and Imran *et al.* (2010) who also reported fodder yield as varietal character. It can also be assessed that cultivars possessed high genetic potential for higher fodder production as also reported by Hediat-Ullah *et al.* (2012).

Table 2: Yields of fresh, dry, protein and total digestible nutrients of six mungbean varieties(average of two seasons 2011-2012).

Variety	Fresh yield (ton/fed.)			Dry yield (ton/fed.)			Protein yield (kg/fed.)			TDN yield (ton/fed.)		
	1st Cut	2nd Cut	Total	1st Cut	2nd Cut	Total	1st Cut	2nd Cut	Total	1st Cut	2nd Cut	Total
King	12.7 a	7.9 a	20.6 a	2.25 a	1.88 a	4.13 a	389 a	311 a	700 a	1.46 a	1.17 a	2.63 a
V2010	10.6 c	6.5 c	17.1 d	1.82 c	1.57 c	3.39 d	313 c	256 c	569 d	1.18 c	0.97 c	2.15 d
VC15	9.0 e	5.4 d	14.4 e	1.61 d	1.30 d	2.91 e	270 e	211 d	481 e	1.05 d	0.81 d	1.87 e
VC20	9.6 d	7.3 b	16.9 d	1.67 d	1.77 b	3.44 d	283 d	289 b	571 d	1.09 d	1.09 b	2.19 d
VC1000	10.4 c	7.9 a	18.3 c	1.84 c	1.87ab	3.71 c	304 c	298 ab	602 c	1.67 c	1.15 ab	2.32 c
Kawmy-1	11.2 b	8.1 a	19.3 b	2.00 b	1.94 a	3.94 b	333 b	306 a	639 b	1.27 b	1.19 a	2.46 b

Forage quality:

The chemical analysis of the tested mungbean varieties on both first and second cuts are given in Tables (3 and 4). Generally, the data of forage quality of the second cut possessed lower content of CP, Ash and TDN this may be due to that the first cut possessed greater assimilates especially in the pods than the second cut which reflected in these criteria of forage quality. It could be noticed that significant differences among mungbean varieties were recognized. Mungbean cv. King produces higher amount of crud protein, ether extract, ash and total digestible nutrients but, lower amount of crud fiber and nitrogen free extract in the first and second cuts, followed by mungbean cv. V2010. The lowest amount of crude protein, ash and total digestible nutrients were recorded in mungbean cvs. VC1000 and Kawmy-1 in the first and second cuts. These mungbean varieties generally produce forage high in content of crude protein, ash and total digestible nutrients but, low in content of crud fiber and nitrogen free extract compared with fodder maize. Similar results were obtained by Attia-Ismail and Afiah (1998); Chumpawadee *et al*. (2007) and Khatik *et al*. (2007). They found that the green gram straw contained 88.20, 88.57, 9.70, 26.57, 2.39, 49.91 and 11.43%, dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen-free extract (NFE) and ash, respectively. The digestibility values of DM, OM, CP, CF, EE and NFE were 58.13 and 52.87, 61.44 and 56.25, 68.98 and 61.69, 61.81 and 55.14, 69.46 and 66.18 and 55.30 and 54.09, respectively, in sheep and goats. Also, reported by Abd El-Salam *et al*. (2008).

Table 3: Chemical composition and percent of total digestible nutrients of six mungbean varieties at the first cut (average of two seasons 2011-1012).

Variety	*DM%	% on dry matter basis					
		CP	CF	NFE	EE	Ash	TDN
King	17.7	17.32 a	21.20 b	44.32 bc	2.12 ab	15.04 ab	65.02 abc
V2010	17.2	17.18 a	21.49 b	44.60 abc	2.07 ab	14.66 c	64.76 c
VC15	17.9	16.73 b	20.52 c	45.17 ab	2.16 a	15.42 a	65.31 ab
VC20	17.5	16.91 ab	20.44 c	45.45 a	2.06 ab	15.14 ab	65.43 a
VC1000	17.6	16.68 b	22.90 a	43.98 c	2.04 ab	14.4 cd	63.56 d
Kawmy-1	17.8	16.63 b	22.96 a	44.15 bc	2.00 b	14.26 d	63.49

*Not statistically analyzed.

Table 4: Chemical composition and percent of total digestible nutrients of six mungbean varieties at the second cut (average of two seasons 2011-1012).

Variety	*DM%	% on dry matter basis					
		CP	CF	NFE	EE	Ash	TDN
King	23.9	16.52 a	24.54 b	44.24 bc	2.01 a	12.69 a	62.30 ab
V2010	24.1	16.31 ab	24.67 b	44.36 bc	1.94 a	12.72 a	62.13 bc
VC15	24.2	16.21 b	24.03 c	45.39 a	1.93 a	12.44 a	62.56 a
VC20	24.1	16.32 ab	25.00 ab	43.88 c	1.96 a	12.84 a	61.89 cd
VC1000	23.8	15.76 c	25.45 a	44.25 bc	1.99 a	12.55 a	61.37 e
Kawmy-1	23.9	15.82 c	24.91 b	44.72 ab	1.94 a	12.61 a	61.79 d

*Not statistically analyzed.

Conclusion:

It could be concluded from this study that the promising multi-cutting mungbean varieties with the high nutritive value could effectively be employed to narrow the summer green forage gape and overcome the critical forage shortage period in Egypt.

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