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EFFECT OF PLANT AGE AT HARVESTING ON FORAGE YIELD AND QUALITY OF MILLET *(Penisetum americanum, L.)* IN SANDY SOIL

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ABSTRACT

The present field investigation was carried out to study the effect of plant age at cutting on yield and quality of forage millet (cv.Shandwil-1) grew on newly reclaimed sandy soil at Ismailia Agricultural Research Station, ARC. The experimental design was a randomized complete block with four replications .The study included four plant ages at cutting represented by 60, 80, 100 and 120 cm plant height. The trail was conducted during the summer season of the year 2000 and 2001. Significant differences were found among the four different plant ages at cutting and the results showed that cutting at plant height of 120 cm caused a significant increase of fresh yield, dry yield, crude fiber and ash; also the same treatment gave the lowest values of toxic components (oxalic acid and alkaloids). On the other hand, cutting at 60 cm plant height gave the highest values of crude protein and TDN, while the same treatment gave the highest values of toxic components (oxalic acid and alkaloids). Also there were no significant differences between cutting at 100 and 120 cm plant height on all chemical composition, TDN and alkaloids. Insignificant differences between 100 and 120 cm plant height may assure that cutting at 120 cm plant height could be recommended to give high yield of low toxic chemical components. While cutting at 60 cm height will save 54 days of the summer growing season to grow early winter crop as berseem and obtain one or two cuts more than late planting.

Keywords: Forage millet, sandy soil, yield, chemical composition and toxic chemical components.

INTRODUCTION

The increased deficiency of green forage in the summer season in Egypt requires more attention to increase the yield of summer forage crops including pearl millet (*Penisetum americanum, L.*).This can be achieved by growing improved varieties and optimizing the cultural practices to realize their yielding potential.

In respect of pearl millet, information on the effect of the cutting management on forage yield is limited especially for sandy soil.

Pearl millet was found to be more productive than sudan grass or sorghum X sudan grass hybrid under sandy soil at Ismailia (Egypt) (Mousa *et al.*, 1995).

Ghobrial *et al.*, (1984) found that the highest green yield of pearl millet was obtained by cutting at 100 cm height. Nor El-din *et al.*, (1992) studied the effect of plant height during cutting of millet and guar mixture. They found that cutting the stand when millet plants in the mixture reached 80-100 cm gave the highest fresh and dry yields. Soliman (2000) evaluated the performance of forage millet under two cutting systems, with the first cut 75 and 90 days after sowing and second cut 120 and 150 days after sowing .He found that fresh and dry yield and protein yield per unit area increased significantly when the first cut was taken 90 days from sowing and the second cut 150 days from sowing.

Abdalla and Darwish (1972) reported that forage yield of Napier grass increased significantly as the interval between clippings was extended to three months, while the increase in the cutting interval to four months resulted in small and insignificant increase in yield.

Rangil *et al.*, (1973) found that oxalate and minerals content in the *Pennisetum purpureum* X *P.americanum* hybrid NB21 decreased with age on leaves having higher concentration of these constituents than stems. Krejsa *et al.*, (1984) reported that pearl millet forage is less palatable under stress condition due to a higher level of total alkaloids relative to palatable. Forage leaf blades were found to contain more total alkaloids than stem plus leaf sheathes 75 vs. 17 mg kg^{-1}, respectively.

The farmer used to harvest three cuts during the summer growing season of millet, cutting time depends on the availability of feed stuff to his animals regardless of the maturity stage of the crop which severely affects the feeding value of the diet.

The present investigation aimed to study: 1- the effect of plant age of millet plant to identify the suitable age of harvesting which result in high forage yield of good quality and low toxic components when grown in sandy soil. 2- The difference in growing season between the early and late cutting in order to grow the succeeding crop as early as possible.

MATERIALS AND METHODS

A field trial was carried out at the Ismailia Agricultural Research Station (ARC), during the two successive summer seasons, 2000 and 2001, to evaluate the effect of age at cutting on yield, chemical composition and some toxic chemical components (Oxalic acid and Alkaloids) on forage millet (cv.Shandwil-1). Soil at the experimental site was sandy with average composition of 6.82% coarse sand; 36.40% fine sand;1.56%silt; 0.22%clay;0.004 %total nitrogen; 0.34 % organic matter and pH 7.8 . The trial was sown on 8 May and 22 April in the first and second seasons, respectively. Irrigation water was supplied through sprinkler irrigation system. The experimental design was a randomized complete block with four replications. Plots 2X4 m^2 and seeding rate was at 20 kg seed /fed. in rows 20 cm apart. Phosphorus (calcium super phosphate(15.5%P_2O_5) and Potassium (K sulphate(48%K_2O)) were added as a single dose before sowing at a rate of 200 kg/fed. and 100 kg/fed., respectively. The trial included four cutting treatments based on plant height at cutting i.e. 60, 80,100 and 120cm. Plant height was estimated as average of 10 randomly selected plants from each replicate for each treatment. Three cuts were taken during each growing season. Fresh and dry forage yield (ton/fed.) was recorded at each cut in both seasons. Table 1 show the average plant age in days and air temperature for each cut for the two seasons of the trial.

Composite samples of dry forage of each cut of the first season were chemically analyzed for crude protein (CP %), crude fiber (CF %), ash % and oxalic acid (mg/100g) contents following the conventional methods recommended by A.O.A.C. (1980). Alkaloids (ppm) were determined according to the method of Peach and Tracey (1955). Forage quality as TDN

was estimated according to prediction equation for grasses (Adams *et al.*, (1964)
as: TDN = 50.41+ 1.04 CP – 0.07 CF.

Data were statistically analyzed according to procedures outlined by Snedecor and Cochran (1980) using MSTAT computer program V.4 (1986). Simple correlation coefficients were determined.

Table (1): Average plant age in days and air temperature over seasons for the plant height cutting treatments.

Plant height	From sowing to 1st cut		From first to 2nd cut		From second cut to 3rd cut		Growing season (days)
	Plant age (days)	Air temp. C°	Plant age (days)	Air temp. C°	Plant age (days)	Air temp. C°	
60 cm	46	25	30	30	28	30	104
80 cm	57	27	37	29	29	29	123
100 cm	67	30	39	31	39	26	145
120 cm	77	31	42	27	39	24	158

RESULTS AND DISCUSSION

Forage yield:

Plant height at cutting significantly affect fresh and dry forage yield of each cut and seasonal yield (Table 2). The highest fresh and dry forage yields were obtained from cutting at plant height of 120 cm. Comparison among different treatments, in the first and second seasons (Table 2) shows that there were significant differences in fresh and dry forage yield between 60 and 120 cm plant height at cutting in the first, second, third cuts and total yield. The percentage increment in fresh and dry yields ranged from 22.72 to 17.60 % and from 25.89 to 25.34 % from the first to the third cut in the first season, respectively. In the second season the percentage increment in fresh and dry yields ranged from 57.08 to 26.52 % and from 51.76 to 42.54 % from the first to the third cut, respectively. The percentage increments in total fresh and dry yields were 24.87, 32.72 % in the first season and 41.91, 53.13 % in the second season, respectively. On the other hand the data presented in Table (2) showed that there were significant differences in fresh and dry forage yield between 100 and120 cm plant height at cutting, but the range of differences in the percentage of increment was lower either in the first or in the second season and the percentage increment in fresh yield ranged from 2.0 to 10.15 % and dry yield ranged from 0.71 to 10.24 % from the first to the third cut in the first season. In the second season the percentage of increment of fresh yield ranged from 2.52 to 14.59% and dry yield ranged from 4.65 to 16.46 % from the first to the third cut, respectively. However the percentages increment in total fresh and dry yields were 8.85, 8.17 % in first season and 12.62, 15.05 % in the second season. The combined analysis over the two seasons (table 3) showed significant differences between harvesting treatments in total fresh and dry yield. The percentage increase in total fresh and total dry yields averaged over seasons were 31.18, 42.29 % for the 120 cm plant height treatment, respectively. Thus delaying cutting or grazing to the time when the plants are more mature could lead to rapid regrowth which will result in higher yield.

Table (2): Effect of plant height at cutting on fresh and dry yields (ton/fed.) of forge millet (cv.Shandwil-1).

Treatment	(2000)								(2001)							
	Fresh yield (ton/fed.)				Dry yield (ton /fed.)				Fresh yield (ton/fed.)				Dry yield (ton /fed.)			
	Cut 1	Cut2	Cut3	Tota	Cut 1	Cut2	Cut3	Total	Cut 1	Cut2	Cut3	Total	Cut1	Cut2	Cut3	Total
60 cm	6.25	6.67	7.84	20.76	1.12	1.22	1.46	3.80	4.66	6.25	7.20	18.11	0.85	1.16	1.34	3.35
80 cm	6.68	7.15	8.00	21.83	1.17	1.31	1.59	4.07	5.73	6.62	7.63	19.98	1.05	1.25	1.44	3.74
100 cm	7.47	8.10	8.37	23.94	1.40	1.59	1.66	4.65	7.14	7.73	7.95	22.82	1.29	1.52	1.64	4.45
120 cm	7.67	9.04	9.22	25.93	1.41	1.79	1.83	5.03	7.32	9.27	9.11	25.70	1.35	1.86	1.91	5.12
LSD(0.05)	0.36	0.30	0.18	0.17	0.063	0.06	0.08	0.14	1.23	1.43	1.59	4.04	0.19	0.27	0.30	0.59

Table (3): Average effect over two seasons of plant height on fresh and dry yield (ton/fed.).

Treatment	Combined							
	Fresh yield (ton/fed.)				Dry yield (ton/fed.)			
	Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Cut 3	Total
60 cm	5.45	6.49	7.50	19.44	0.98	1.19	1.40	3.57
80 cm	6.20	6.89	7.82	20.91	1.11	1.28	1.50	3.89
100 cm	7.26	7.91	8.16	23.33	1.38	1.56	1.65	4.59
120 cm	7.50	9.19	9.17	25.86	1.39	1.83	1.87	5.09
LSD 0.05	0.43	0.54	1.03	1.59	0.08	0.11	0.06	0.22

Forage quality:

1-Chemical composition and total digestible nutrients:

1-1 Chemical composition:

Crude protein (%) content varied significantly ($P<0.05$) in different ages under investigation in the individual cutting (Table 4). Cutting the plant at 60 cm height ranked first in CP% in almost all cuttings. Table 4 shows that there were significant differences between cutting at 60 and 120 cm plant height and the percentage increment in CP ranged from 22.42 to 24.46 % from the first to the third cut, respectively. However the differences in CP between 100 and120 cm plant heights were not significant and ranged from 6.63 to 6.93 % from the first to the third cut.

Table (4): Effect of plant height at cutting on chemical composition (%) of forage millet (cv.Shandwil-1).

Treatment	Chemical composition											
	CP (%)				CF (%)				Ash (%)			
	Cut 1	Cut 2	Cut 3	Mean	Cut 1	Cut 2	Cut 3	Mean	Cut 1	Cut 2	Cut 3	Mean
60 cm	11.63	10.72	9.87	10.74	26.20	27.50	28.50	27.40	8.25	7.63	6.95	7.61
80 cm	11.24	10.34	9.55	10.38	28.10	29.32	29.70	29.04	8.81	8.10	7.63	8.18
100 cm	10.13	8.70	8.48	9.10	30.30	30.83	31.20	30.77	9.17	8.54	8.05	8.58
120 cm	9.50	8.22	7.93	8.55	31.04	31.29	31.81	31.38	9.26	8.66	8.18	8.70
LSD 0.05	0.88	1.36	0.97	-	1.84	1.39	1.66	-	0.67	0.73	0.60	-
Mean	10.63	9.50	8.96	-	28.91	29.74	30.30	-	8.87	8.23	7.70	-

These results agree with Worker and Marble (1968) who reported that total crude protein production varied by variety and stage of harvest in sudan grass. The maximum production for sudan grass occurred at the boot stage and decreased as harvest was delayed.

Crude fiber (CF %) varied significantly (P<0.05) among cutting treatments. The data presented in Table 4 show that cutting at 120 cm height gave the highest CF 31.04, 31.29 and 31.81% in the first, second and third cut, respectively. There were significant differences between 60 and 120 cm plant height, while the differences between 100 and120 cm plant heights were not significant.

Regarding ash content, the data presented in Table 4 indicated the presence of significant differences among cutting treatments, cutting at 120 cm height ranking first in ash content i.e. 9.26, 8.66 and 8.18% in the first, second and third cut, respectively. Table (4) shows that there were significant differences between the 60 and 120 cm cutting height, while the differences between 100 and 120 cm cutting heights were not significant.

1-2- Total digestible nutrients:

Results of TDN percentages in forage millet as affected by different plant ages at cutting are presented in Table (5).Among different plant heights at cutting, the statistical analysis indicated the presence of significant differences in TDN percentage. The 60 cm plant height at cutting had the highest TDN % in almost all cuts. Table (5) showed that there were significant differences between 60 and 120 cm plant height at cutting and the percentage increment in TDN between 60 and 120 cm plant height at cuttings ranged from 4.42 to 2.79 % from the first to third cut, respectively. While the differences between 100 and 120 cm were not significant. Huffman (1959) mentioned that at the different stage of maturity both grasses and alfalfa increased in the yield amount and digestibility.

Table (5): Effect of plant height at cutting on TDN (%) of forage millet (cv.Shandwil-1).

Treatment	TDN (%)			
	Cut 1	Cut 2	Cut 3	Mean
60 cm	60.67	59.62	58.01	59.43
80 cm	60.30	59.11	58.27	59.23
100 cm	58.82	57.29	57.04	57.72
120 cm	58.10	56.76	56.43	57.09
LSD 0.05	1.02	0.90	1.29	-
Mean	59.47	58.20	57.44	-

2-Toxic chemical components:

Regarding to the toxic chemical components (oxalic acid and alkaloids) the results in Table 6 indicated the presence of differences between the different plant ages at cutting on forage millet reached to the level of significance. The results in Table 6 showed that cutting at 60 cm plant height gave the highest values of oxalic acid and alkaloids in almost all cuts, while cutting at 120 cm plant height gave the lowest values of oxalic acid and alkaloids in almost all cuts under investigation. Table 4 showed that there were significant differences in oxalic acid and alkaloids between 60 and 120 cm plant height at cutting. Also, there were significant differences between

100 and 120 cm plant height in oxalic acid, while the differences between 100 and 120 cm in alkaloids were not significant.

These findings are in conformity with those obtained by Rangil *et al.*, (1973) who mentioned that oxalic acid and total minerals decreased with advanced age.

Table (6): Effect of plant height at cutting on toxic chemical components of forage millet (cv.Shandwil-1).

Treatment	Toxic chemical components							
	Oxalic acid (mg/100g)				Alkaloids(ppm)			
	Cut1	Cut2	Cut3	Mean	Cut1	Cut2	Cut3	Mean
60 cm	290.7	474.8	709.0	491.5	66.43	70.49	73.12	70.01
80 cm	240.4	389.0	609.7	413.0	56.47	60.62	63.61	60.23
100 cm	225.2	355.8	510.5	363.8	49.03	52.86	53.94	51.94
120 cm	212.2	341.5	492.6	348.8	47.53	51.43	53.79	50.92
LSD(0.05)	24.69	9.46	9.97	-	6.03	6.95	6.39	-
Mean	242.13	390.3	580.5	-	54.87	58.85	61.12	-

Correlation coefficient:

The results of simple correlation coefficient among the studied traits are given in Table (7). Dry matter yield was significantly negatively correlated with CP, TDN and significantly positive correlated with CF and insignificantly correlated with oxalic acid and alkaloids. While CP had significantly positive correlation with TDN, significantly negative correlation with CF. Crude fiber showed a negative and significant correlation with TDN, significantly positive correlation with alkaloids. While oxalic acid had significant positive correlation with alkaloids.

Table (7): Correlation coefficient among the studied traits evaluated on forage millet (Shandwil-1) cultivar.

Treatment	CP	CF	TDN	Oxalic acid	Alkaloids
DM	-0.974**	0.859**	-0.967**	0.357	-0.423
CP		-0.911**	0.991**	-0.276	0.500
CF			-0.892**	-0.01	0.759**
TDN				0.343	0.440
Oxalic acid					0.637*

CONCLUSION AND RECOMMENDATION

Although the results revealed Insignificant differences between 100 and 120 cm plant height at cutting in chemical composition, TDN and alkaloids which may assure that cutting at 120 cm plant height could be recommended to obtain high yield with low toxic chemical components, it is not necessarily the most efficient treatment, either in resource utilization or in economic efficiency. Postponing cutting could result in higher yield, but we are losing resources during postponing time. This could only be ruled out by the grower based upon the prevailing situation and the net return.

Cutting at 60 cm height resulted on getting 19.44 tons as average seasonal yield of the two seasons compared to 25.86 tons when cut at 120

cm height but the lower yield was obtained at 104 days, while the higher yield was obtained at 158 days which makes 54 days difference. The farmer will have the choice between getting six tons more in summer when cut at 120 cm height and lose this toning when cut at 60 cm height but he will gain time to grow berseem early in the season and have one or two berseem cuts more.

The farmer prefer to take one more cut from berseem rather than taking very weak yield of the forth cut of forage millet, therefore we included a treatments in this experiment to mimic these practice.

This work should be completed by extensive research work both economical and digestibility points of view.

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تأثير عمر النبات عند الحش علي كمية المحصول وجودة العلف في الدخن في الأراضي الرملية

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أجريت تجربة حقلية لدراسة تأثير عمر النبات عند الحش على محصول و نوعية العلف في الدخن صنف (شندويل-١) تم زراعتها في ارض رملية حديثة الاستصلاح في المزرعة البحثية لمحطة البحوث الزراعية بالأسماعيلية. و كان التصميم الأحصائي قطاعات كاملة العشوائية في أربعة مكررات. و قد اقيمت التجربة خلال الموسم الصيفي لعام ٢٠٠٠،٢٠٠١ و تضمنت أربعة أعمار نبات عند الحش هي ٦٠و٨٠و١٠٠و١٢٠ سم .

و قد أظهرت النتائج أن هناك إختلافات معنوية بين الاعمار المختلفة عند الحش وأن الحش عند طول ١٢٠ سم تسبب في زيادة معنوية في المحصول الأخضر و المحصول الجاف و الألياف الخام و الرماد و أيضا اعطى نفس الطول أقل قيم من المواد السامة (الأكساليك أسيد و القلويدات).

و من ناحية أخرى فقد أعطى الحش عند طول ٦٠ سم أعلى قيم من البروتين الخام و المواد المهضومة الكلية ولكن نفس الطول أعطى أيضا أعلى قيم من المواد السامة (الأكساليك أسيد و القلويدات).

أيضا وجد انه لم تكن هناك اختلافات معنوية بين الطول ١٠٠و١٢٠ سم عند الحش في التركيب الكيماوي و المواد المهضومة الكلية و القلويدات.

عدم وجود فروق معنوية بين الطول ١٠٠و١٢٠ سم يؤكد ان الحش عند ١٢٠ سم يمكن ان يوصى به للوصول الى أعلى محصول واقل مواد سامة.

بينما نجد ان الحش عند ارتفاع ٦٠سم سوف يوفر ٥٤ يوم من موسم النمو الصيفي لزراعة محصول شتوي مبكر مثل البرسيم والحصول على حشة او اثنين اكثر عنه في حالة التأخير في الزراعة.