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FORAGE YIELD AND QUALITY OF PEARL MILLET (*Pennisetum americanum*) AS INFLUENCED BY ROW SPACING AND SEEDING RATE IN SANDY SOIL.

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ABSTRACT

The present study was set up at Ismailia Agric. Research Station of ARC, during 2001& 2002 seasons to study the effect of three row spacing (20, 40 and 60 cm between rows) and four seeding rates (10, 15, 20 and 25 kg seeds/fed)on forage yield and quality of pearl millet. The experimental design was a split-plot in which row spacing levels were assigned to the main plots and seeding rates to the sub-plots. No significant differences between planting in 40 and 60 cm row spacing on fresh and dry forage yields as well as crude protein yield were detected. However, planting millet with 20 cm row spacing produced the highest and significant fresh and dry forage yields in addition to crude protein yield for the two seasons and their combined. On the other hand, total fresh, dry and crude protein yields were increased by increasing seeding rate up to 25 kg seeds/fed. The interaction between row spacing and seeding rate was significant. In general, the highest total fresh, dry and crude protein yields were obtained from planting in 20 cm and using seeding rate of 25 kg seeds/fed.

Keywords: Pearl millet, Yield, Seeding rate and Row spacing.

INTRODUCTION

Pearl millet (*Pennisetum americanum* L.) is considered as one of the most important fodder grasses for arid and semi arid areas of the world. Pearl millet is being a dual purpose crop grown as a grain and fodder crop. In Egypt, its importance as fodder crop is more than grain. Besides being a potent source of food for human, it is considered also an excellent forage grass for cattle and other classes of ruminants. It is quick growing and palatable to animals. It gives from two to four cuts and supplies green fodder during summer. In order to develop better fodder production of pearl millet, several agronomical practices were studied.

Yield in most crops ultimately depends on the seeding date (Khatir and Vanderlip, 1992 and Singh and Sharma, 1999); seeding rate (Elshahawy et al., 1994); variety (Hazra and Shukla, 1998 and Bainiwal et al., 1999) and N-fertilizer rate as well as other nutrients (Yadava and Solanki, 2002) which affect the production per unit area. Plant density plays a significant role in plant expression, biological productivity and finally governing crop yields. Many authors studied the effect of plant population density on growth and productivity of pearl millet (Kaushik and Gautam, 1991 and Craufurd and Bidinger, 1989).

With a clay soil which has received a lot of attention in the world, many investigators showed that a great potential of influence of seeding rate on forage graminaceous production as well as forage quality (Richard and Burton, 1965; Nirval and Upadhyay, 1979). Total fresh and dry forage yields

were increased by increasing seeding rate of pearl millet up to 22 kg/fed (Elshahawey et al., 1994). Similar results were obtained on sorghum by (Haggag et al., 1986 and Mahmoud and Elshahawy, 1995) which reported that high fresh forage and crude protein yields were achieved by increasing seeding rate. In sandy soil of Ismailia which had a little of concern with pearl millet cultivation and no research work has been done, so far regarding its cultural practices requirements. Keeping this in view, the present study was planned. The objective of this investigation was to study the effect of row spacing and seeding rate on forage yield and quality of pearl millet under the circumstances of irrigated sandy soil in Ismailla.

MATERIALS AND METHODS

Two field experiments were conducted at the research farm of the experimental station of Ismailia, ARC during summer 2000 and 2001 seasons which were seeded on May 7th and April 30th respectively. The plant material used in this study was pearl millet seeds cv. Shandawil-1. The physical and chemical properties of the soil are presented in Table (1). Calcium super phosphate (15.5% P2O5) at the rate of 100 kg/fed was applied during soil preparation. Nitrogen fertilization (Ammonium sulphate 21.6%) was applied at a rate of 120 kg/N/fed in four equal doses; the first dose was applied two weeks after germination, while the second, third and fourth doses were applied after the first, second and the third cuts.

Table (1): Initial physical and chemical analysis of the soil before conducting the experiment.

1. Mechanical analysis:	
Coarse sand (%)	58.62
Fine sand (%)	34.97
Silt (%)	3.88
Clay (%)	2.53
Soil texture	Sandy
2. Chemical analysis:	
pH (1:2.5 suspension)	7.58
EC (mmoles cm^{-1} (1:5)	0.098
Organic matter (%)	0.029
Available N, ppm (K-sulphate extract)	6.88
Available P, ppm ($NaHCO_3$ method)	1.27
Available K, ppm (Amm. Acetate extract)	51.90

A split plot design with four replications was used. Row spacing occupied the main plots with three levels (20, 40 and 60 cm.), while seeding rates were arranged in the subplots with four levels (10, 15, 20 and 25 kg seeds/fed). Each sub-plot size was 3x3 m. Pearl millet seeds were drilled in rows under sprinkler irrigation and other agronomic practices were adopted as recommended. At the seedling stage, number of plants per row was counted in each season and the average of the two seasons is listed in Table (2). Four cuts through each growing season were taken after 55, 100, 140

and 175 days from sowing. Harvested fresh forage yield was weighted as kg/plot and converted to ton/feddan. Dry forage yield was determined according to dry forage percentage recorded. At each cut in both season, plant height (means of ten plants) was estimated. The oven dried samples for the four cuts were used for qualitative analysis (crude protein) by using the method as described by AOAC (1990). Crude protein yield was calculated as kg/fed by calculating crude protein percentage multiplied by dry forage yield. Data were statistically analyzed using MSTAT. Ver 4. (1986). Combined analysis over two seasons was also executed for both seasons.

Table (2): Average of population density of pearl millet within row in the two seasons (# plants per row)

Row spacing	Seeding rate (kg/fed)				
	10	15	20	25	Mean
20 cm	134.0	181.0	241.0	295.0	212.8
40 cm	251.0	331.0	449.0	605.0	409.0
60 cm	402.0	519.0	683.0	884.0	622.0
Mean	262.3	343.7	457.7	594.7	-

RESULTS AND DISCUSSION

1- Effect of row spacing:

The effect of row spacing on the fresh yield of fodder pearl millet was presented in Table (3). It is clear from the data of season 2000 that there is a significant effect of planting in 20 cm row spacing on fresh yield through the four successive cuts and their total. Highest total fresh yield was obtained from 20 cm row spacing which produced 23.54 ton/fed compared with 20.94 and 21.78 ton/fed for the other two treatments (40 and 60 cm) respectively. On the other hand, data of season 2001 had the same trend where the highest fresh yield resulted from treatments of 20 cm row spacing. This treatment produced 21.92 ton/fed for total fresh yield while the two other treatments gave 20.51 and 19.51 ton/fed for 40 and 60 cm row spaces, respectively. In addition, the data of combined analysis over the two seasons revealed that there is a significant effect due to row spacing on total fresh yield. Increase of total fresh yield due to planting in rows 20 cm apart was higher than planting in rows 40 or 60 cm apart by 9.65% and 10.07%, respectively.

The data presented in the same table show the effect of row spacing on dry matter yield for the two seasons (2000 & 2001) and combined analysis over the two seasons. In the first season, results obtained followed a trend some what similar to that of fresh forage yield. Differences between row spacing treatments were significant. Increases in dry forage yield were obtained particularly from treatment applied at the 20 cm row spacing in the four cuts as well as the total dry matter yield which reached to 13.51% and 8.70% over the two other treatments. However, data of season 2001 (Table 3) show that no significant differences between the three row spacing at the first and second cuts. At the third cut, 20 cm distant between rows gave

significantly higher yield over the 60 cm treatment. At the fourth cut, yield of 20 cm distance was significantly higher than 40 and 60 cm row spacing. Moreover, results obtained from the combined analysis indicated that planting in rows 20 cm apart resulted in a higher total dry matter yield and the increases over the other two treatments were 9.05 and 8.27% respectively. Many investigators came to similar conclusion on sorghum (Mahmoud and El-Shahawy, 1995) and on millet (El-Shahawy et al., 1994).

Table (3): Effect of row-spacing on fresh and dry matter yield of forage pearl millet for two seasons 2000 and 2001 as well as their combined analysis

Treatment	Fresh yield (ton/fed)										
	Year 2000					Year 2001					Comb.
	Cuts					Cuts					
	1st	2nd	3rd	4th	Total	1st	2nd	3rd	4th	Total	
Row spacing											
20 cm	5.79	5.96	6.12	5.67	23.54	5.61	6.10	5.45	4.76	21.92	22.73
40 cm	4.96	5.34	5.68	4.96	20.94	5.63	5.47	5.15	4.26	20.51	20.73
60 cm	5.17	5.53	5.71	5.37	21.78	4.74	5.90	4.50	4.37	19.51	20.65
LSD at 0.05	0.43	0.39	0.37	0.32	0.88	0.74	0.45	0.41	0.32	0.91	0.83
	Dry matter yield (ton/fed)										
Row spacing											
20 cm	1.09	1.14	1.17	1.22	4.62	0.96	1.29	1.22	1.06	4.53	4.58
40 cm	0.90	1.02	1.07	1.08	4.07	0.95	1.28	1.16	0.94	4.32	4.20
60 cm	1.01	1.01	1.09	1.14	4.25	0.99	1.27	0.99	0.96	4.20	4.23
LSD at 0.05	0.07	0.06	0.11	0.08	0.34	0.06	0.05	0.06	0.08	0.21	0.18

Effect of seeding rate:

The effect of seeding rate on the fresh fodder yield of millet is presented in Table (4). From the data of seasons 2000 and 2001 it could be noticed that as seeding rate increased fresh fodder yield of millet increased. These increases were significantly recorded also from the combined analysis over the two seasons. The rate of 25 kg seeds/fed produced the highest total fresh yield and the increases over other treatments ranged from 13.76% - 28.55%; 9.39% - 20.86% and 11.65% - 24.80% for the first, second and the combined over the two seasons, respectively. On the other hand, drilling 10 or 15 kg seeds/fed produced the lowest total fresh fodder yield for the two seasons as well as the combined over the two seasons which reached to 19.72, 20.93; 18.98, 20.33 and 19.35, 20.63 kg ton/fed, respectively.

The effect of seeding rate on dry forage yield is presented in Table (4). The differences between dry forage yield as influenced by seeding rate were significant in both seasons and their combined. These differences have approximately the same trend as fresh forage yield. Dry forage yield ton/fed. was significantly increased with increasing seeding rate. Seeding rate at 25 kg seeds/fed produced the highest dry forage yield of millet as compared with the other three seeding rates. The increase of total dry yield for first and second seasons as well as their combined for the treatment received 25 kg seeds/fed over 10, 15 and 20 kg seeds/fed were 33.60, 25.94 and 13.74%, 29.32, 19.90 and 12.79%, and 31.58, 22.85 and 13.38%, respectively.

Increasing fresh and dry matter yield as a result of increasing seeding rate is related to increasing plant population density which may be

due to the high amount of energy intercepted by leaves and well utilization of water and nutrients per unit area which might contributed much to weight of plants per feddan in dense planting (Hagag et al., 1986). Also, this was probably because of the high compensation ability of the millet at poor soil and low water holding capacity (Katir and Venderlip, 1992). Since this investigation was carried out under Ismailia conditions in sandy soil which which has a poor fertility, increasing seeding rate might help increase more nutrients and water uptake which led to increasing dry matter. Our results agree with those of many workers in clay soil (El-Shahawy et al., 1994). They reported that the total fresh and dry matter yield of pearl millet were increased by increasing seeding rate up to 22 kg seeds/fed.

Table (4): Effect of seeding rate (kg/fed) on fresh and dry yield of forage pearl millet for two seasons (2000 and 2001) as well as their combined analysis

	Fresh yield (ton/fed)										Comb
	Cuts					Cuts					
	1st	2nd	3rd	4th	Total	1st	2nd	3rd	4th	Total	
10	4.65	5.02	5.40	4.65	19.72	5.24	5.09	4.57	4.08	18.98	19.35
15	5.05	5.38	5.60	4.90	20.93	5.67	5.59	4.82	4.25	20.33	20.63
20	5.25	5.68	5.80	5.55	22.28	5.97	5.19	5.20	4.61	20.97	21.63
25	6.28	6.37	6.50	6.20	25.35	6.41	6.08	5.55	4.90	22.94	24.15
LSD at 0.05	0.32	0.39	0.25	0.30	0.88	0.71	0.32	0.26	0.47	1.08	0.85
	Dry matter yield (ton/fed)										
10	0.85	0.94	1.01	0.98	3.78	0.82	1.12	1.01	0.87	3.82	3.80
15	0.93	0.99	1.05	1.04	4.01	0.89	1.23	1.07	0.93	4.12	4.07
20	0.96	1.08	1.20	1.20	4.44	0.95	1.23	1.17	1.03	4.38	4.41
25	1.18	1.21	1.26	1.40	5.05	1.14	1.43	1.25	1.12	4.94	5.00
LSD at 0.05	0.05	0.05	0.12	0.05	0.32	0.07	0.05	0.08	0.09	0.21	0.11

Row spacing X seeding rate interaction:

Results in Table (5) summarize a significant effect of the row spacing X seeding rate interaction on forage yield. This was true for each of the four successive cuts and the accumulated total fresh yield as well as in both seasons and their combined. In season 2000, the highest total fresh yield (27.73 ton/fed) was obtained when millet was grown in 20 cm as a row spacing with 25 kg/fed seeding rate. This trend was similar for the four single cuts. However, it could be noticed that, the lower fresh forage yield was produced when millet was grown with 10 or 15 kg seeds/fed. Regarding season 2001 and combined analysis, the data in Table (5) indicated significant effect of this interaction on forage fresh yield. The highest total fresh forage yield (25.85 ton/fed) of combined analysis was obtained when millet was grown in rows 20 cm apart and 25 kg/fed seeding rate. No significant differences were observed on total fresh yield of combined

analysis when millet was planted with 20 cm row space interacted with 20 kg seeding rate (23.43 ton/fed) and the two other treatments which received 25 kg seeding rate but planted with 40 or 60 row spacing (23.58 and 23.08 ton/fed), respectively.

Table (5): Effect of row spacing X seeding rate interaction on fresh yield of forage pearl millet for two seasons 2000 and 2001 as well as combined analysis

Treatments		Fresh yield (ton/fed)										
		Year 2000					Year 2001					Comb.
		Cuts					Cuts					
		1st	2nd	3rd	4th	Total	1st	2nd	3rd	4th	Total	
20 cm	10	5.09	5.22	5.79	4.80	20.90	4.60	5.61	5.06	4.28	19.55	20.23
	15	5.31	5.58	5.72	4.92	21.53	5.38	5.97	5.31	4.63	21.29	21.41
	20	5.90	6.08	5.85	6.17	24.00	5.99	6.23	5.62	5.01	22.85	23.43
	25	6.88	6.94	7.12	6.79	27.73	6.45	6.56	5.80	5.15	23.96	25.85
40 cm	10	4.29	4.86	5.16	4.34	18.65	4.94	4.97	4.67	3.95	18.53	18.59
	15	4.69	4.93	5.37	4.78	19.77	4.93	5.23	4.80	3.88	18.84	19.31
	20	4.73	5.36	5.38	5.84	21.31	5.16	5.66	5.51	4.45	20.78	21.05
	25	6.14	6.22	6.44	5.86	24.66	6.10	6.00	5.65	4.75	22.50	23.58
60 cm	10	4.58	4.97	5.25	4.81	19.61	4.07	5.15	3.99	4.02	17.23	18.42
	15	5.15	5.62	5.77	5.08	21.62	4.52	5.80	4.34	4.27	18.93	20.28
	20	5.12	5.58	5.80	5.01	21.51	4.43	6.00	4.48	4.38	19.29	20.40
	25	5.83	5.94	6.06	5.96	23.79	5.70	6.66	5.20	4.81	22.37	23.08
LSD at 0.05		0.55	0.34	0.44	0.52	1.46	0.62	0.53	0.45	0.41	1.87	1.58

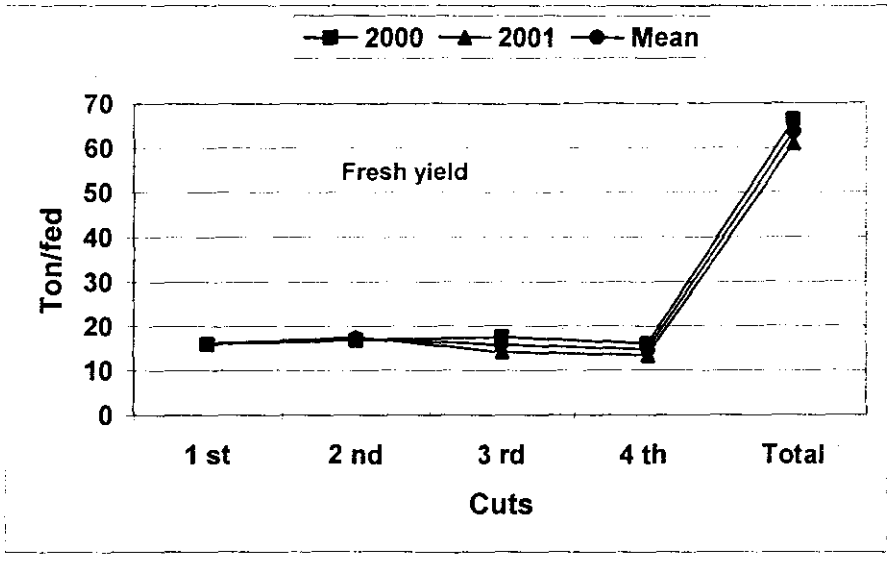
It is clear from the data presented in Table (6) that a similar trend was observed due to the interaction between row spacing and seeding rate on dry matter yield. Results of the two seasons and combined analysis gave a significant effect of the higher level of seeding rate with (25 kg/fed) and 20 cm row space on forage dry yield which reached to 5.38 ton/fed. Applying 20 cm row space resulted in higher dry matter yield when interacted with 15 or 20 kg seeding rates compared with the same level under other row spaces. On the other hand, data of the combined analysis recorded that the lowest dry forage yield was obtained with any row space interacted with seeding rate <20 kg seeds /fed. Therefore, choosing row space and seeding rate as a cultural practice to grow millet is an important choice to harvest the highest fodder yield of millet under these circumstances.

Table (6): Effect of row spacing X seeding rate interaction on dry matter yield of forage pearl millet for two seasons (2000 and 2001) as well as their combined analysis

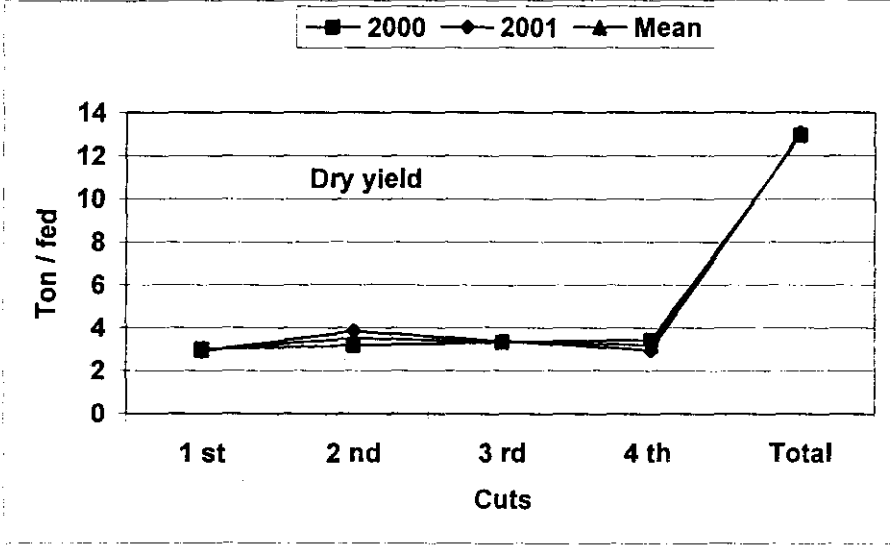
Treatments		Dry matter yield (ton/fed)										
		Year 2000					Year 2001					Comb.
		Cuts					Cuts					
		1st	2nd	3rd	4th	Total	1st	2nd	3rd	4th	Total	
20 cm	10	0.96	1.03	1.10	0.99	4.08	0.87	1.20	1.11	0.93	4.11	4.10
	15	1.01	1.06	1.10	1.01	4.18	0.88	1.32	1.16	1.01	4.37	4.28
	20	1.09	1.12	1.11	1.33	4.65	0.96	1.40	1.28	1.13	4.77	4.71
	25	1.33	1.35	1.37	1.55	5.60	1.14	1.48	1.36	1.18	5.16	5.38
40 cm	10	0.77	0.89	0.97	0.95	3.58	0.75	1.07	1.06	0.81	3.69	3.64
	15	0.84	0.90	1.00	1.00	3.74	0.84	1.12	1.10	0.86	3.92	3.83
	20	0.86	1.12	1.09	1.07	4.14	0.77	1.26	1.25	1.01	4.29	4.22
	25	1.14	1.16	1.24	1.31	4.85	1.07	1.35	1.24	1.08	4.74	4.80
60 cm	10	0.83	0.91	0.98	1.00	3.72	0.84	1.10	0.88	0.87	3.69	3.71
	15	0.93	1.02	1.07	1.10	4.12	0.97	1.26	0.94	0.93	4.10	4.11
	20	0.95	1.01	1.39	1.22	4.57	1.11	1.31	0.99	0.95	4.36	4.47
	25	1.08	1.10	1.16	1.28	4.62	1.21	1.46	1.16	1.08	4.91	4.77
LSD at	0.05	0.04	0.05	0.10	0.05	0.28	0.06	0.05	0.06	0.08	0.21	0.19

Fodder distribution:

Four cuttings of multi-cut fodder pearl millet can be taken successfully under irrigated sandy soil of Ismailia Governorate conditions (Fig 1). The highest green and dry fodder yields were obtained from the second cut, while the lowest fresh and dry fodder yields were obtained from the fourth and first cuts respectively. The percentage of fresh and dry yield of the single cuts of total yield were recorded (25.08, 22.69%); (26.97, 27.00%); (24.84, 25.77%) and (24.84, 24.62%) in the first, second, third and fourth cuts, respectively.



(A)



(B)

Fig (1): Cutting wise mean green (A) and dry (B) yield of multi-cut pearl millet

Effect of row spacing and seeding rate on plant height:

The data illustrated in Table (7) show the combined analysis over the two seasons for the effect of row spacing on the plant height. Results indicated that plant height increased significantly and consistently as row spacing was increased. Appling 20 cm row spacing for planting gave the shortest plants through the four cuts as well as the mean of cuts (104.30 cm) compared with 60 cm row spacing which gave the highest mean of plant height (112.00 cm). This may be attributed to the high competition between plants within row for light and nutrients especially with the high seeding rate within row (Table 2).

Increasing seeding rate from 10 to 25 kg seeds/fed resulted in significant increase in plant height. These increases reached to 16.60, 14.34 and 9.26% over 10, 15 and 20 kg seeds/fed, respectively. Whereas no significant differences were obtained between treatments applied with 10 and 15 kg seeds/fed. Increasing seeding rate from 20 to 25 kg seeds/fed had a significant effect on plant height and the increases were 11.52, 5.70, 7.89 and 11.77% from first to fourth cut, respectively. These results could be explained on the light of competition among plants for growth factors such as light, nutrients, moisture, etc.

Table (7): Effect of row spacing and seeding rate on plant height (cm) of fodder pearl millet (combined over two seasons)

Treatments	Cut 1	Cut 2	Cut 3	Cut 4	Mean
Row spacing (cm):					
20	103.1	107.3	103.0	103.7	104.3
40	108.8	107.5	107.5	102.5	106.6
60	113.1	115.7	113.8	105.3	112.0
LSD at 0.05	**3.34**	**4.54**	**1.68**	**8.83**	-
Seeding rate (kg/fed):					
10	99.9	107.6	103.9	93.4	101.2
15	103.9	105.5	104.5	98.9	103.2
20	108.5	110.6	107.7	105.3	108.0
25	121.0	116.9	116.2	117.7	118.0
LSD at 0.05	**5.11**	**5.04**	**3.35**	**6.02**	-
Interaction					
20cm 10	90.1	104.8	99.5	92.1	96.7
15	100.1	104.1	97.5	95.5	99.3
20	100.4	105.0	102.9	109.0	104.3
25	121.1	115.4	112.0	118.0	116.6
40cm 10	99.8	105.4	101.4	92.4	99.7
15	104.3	98.4	104.6	97.1	101.1
20	111.8	110.8	108.1	103.1	108.5
25	119.5	115.6	115.8	117.3	117.1
60cm 10	109.3	112.8	110.9	95.6	107.1
15	107.3	114.0	111.5	104.0	109.2
20	113.5	116.1	112.0	103.5	111.3
25	122.4	119.8	120.9	117.9	120.2
LSD at 0.05	8.84	9.24	5.80	10.43	-

No significant differences were detected regarding row spacing X seeding rate interaction on plant height especially when pearl millet was planted with high level of seeding rate (25 kg seeds/fed) through four successive cuts. Result of plant height of these treatments were (121.1, 119.5 and 122.4 cm) for the first cut; (115.4, 115.6 and 119.8 cm) for the second cut; (112.0, 115.8 and 120.9 cm) for the third cut and (118.0, 117.3 and 117.9 cm) for the fourth cut interact with 20, 40 and 60 cm row spacing, respectively. On the other hand, there is a significant interaction between row spacing and seeding rate on plant height when pearl millet planted with 20 kg seeds/fed. Pearl millet planted with 20 kg seeds/fed in rows 60 cm apart had a higher plant height than pearl millet sowing under 40 or 20 cm row spacing with the same level of seeding rate. These results could be explained as in the dense sowing, the less intensity of light enhanced the elongation of cells which resulted in taller stem.

Effect of row spacing on crude protein yield:

Results in Table (8) showed no appreciable differences in crude protein yield according to the applied 40 and 60 cm row spacing in second, third, fourth cuts and total protein yield for the first season. However, there was a tendency for the 20 cm row spacing to produce higher crude protein yield with first, fourth, and total cuts. The percentage increases obtained due to applying 20 cm row spacing were 11.03 and 12.69 over 40 and 60 cm row spacing, respectively. The same trend was noticed from the data of second season and combined over the two seasons. As an average over the two seasons, pearl millet plants with 60 cm row spacing had a lowest crude protein yield (629.4 kg/fed) compared with 20 and 40 cm row spacing treatment which had (713.9 kg/fed) and (642.9 kg/fed) crude protein yield, respectively.

Effect of seeding rate:

Effect of seeding rate on crude protein yield was significant in all cuts through the two seasons as well as the combined over the two seasons (Table 8). There was a gradual increase with increasing seeding rate up to 25 kg seeds/fed. The lowest crude protein yield was achieved by decreasing seeding rate to 15 kg seeds/fed for different cuts and their total of the two seasons. Differences between applying 20 and 25 kg seeds/fed resulted in an increment of crude protein yield by 17.59, 14.06 and 15.84% for first, second seasons and combined over the two season, respectively. The increases of crude protein yield due to increasing seeding rate may be resulted in the increase of dry forage yield which affected by increasing the plant population in the unit area. Increasing seeding rate application led to increasing the uptake of nitrogen which is the main constituent of amino acids and protein. Increased population density led to help to scavenge nutrients for soil and uptake of other nutrients which resulted in improving the quality of multi-cut pearl millet. These results are in line with those of Tiwana *et al.* (2003).

Table (8): Effect of row spacing and seeding rate on crude protein yield of forage pearl millet for two seasons (2000 and 2001) as well as their combined analysis

Treatments	Crude protein yield (kg/fed)										
	Year 2000					Year 2001					Comb.
	Cuts					Cuts					
	1st	2nd	3rd	4th	Total	1st	2nd	3rd	4th	Total	
Row space											
20	183.8	180.7	153.0	199.0	716.5	160.5	213.8	175.5	161.5	711.3	713.9
40	153.6	183.3	150.0	158.4	645.3	137.4	195.3	171.6	136.1	640.4	642.9
60	138.5	177.2	148.7	171.4	635.8	141.1	190.9	145.5	145.4	622.9	629.4
LSD at 0.05	10.36	12.83	10.34	14.26	39.10	8.03	9.72	11.02	9.26	50.49	36.68
Seeding rate											
10	138.8	176.2	124.1	169.7	608.8	112.1	172.9	140.1	119.9	545.0	576.9
15	161.4	155.4	128.5	136.7	582.0	142.6	180.7	167.9	123.1	614.3	598.2
20	164.6	179.1	156.1	176.6	676.4	152.9	209.3	177.3	129.9	669.4	672.9
25	169.8	210.9	193.6	221.1	795.4	177.7	237.1	171.4	177.3	763.5	779.5
LSD at 0.05	10.85	9.09	10.12	12.12	39.16	12.04	8.10	11.20	12.20	30.56	36.90

Effect of row spacing X seeding rate:

Crude protein yield as affected by row spacing and seeding rate interaction in both seasons and the combined over the two seasons were significant as shown in Table (9). The highest total crude protein yield was obtained from the treatments planted by 25 kg seed/fed and 20 cm row space. Crude protein yield with all cuts and the total cuts for the two seasons was improved by interacting row spacing with seeding rate especially when higher rates of seeds in 20 cm row spacing were applied. Applying 60 cm row space X 25 kg seeds/fed was comparable to planting pearl millet with 20 kg seeds/fed X 20 cm row spacing.

Table (9): Effect of row spacing X seeding rate interaction on crude protein yield of forage pearl millet for two seasons (2000 and 2001) as well as their combined analysis

Treatments		Crude protein yield (kg/fed)										
		Year 2000					Year 2001					Comb.
		Cut 1	Cut 2	Cut 3	Cut 4	Total	Cut 1	Cut 2	Cut 3	Cut 4	Total	
20 cm	10	168.6	161.1	137.4	193.3	660.4	125.2	175.7	168.4	131.3	600.6	630.5
	15	170.4	160.5	136.8	133.2	600.9	149.6	213.5	175.9	156.3	695.3	648.1
	20	194.6	160.3	138.8	177.2	670.9	162.8	216.2	171.4	191.1	741.5	706.2
	25	201.4	240.9	199.2	292.1	933.6	204.4	249.7	186.2	167.4	807.7	870.7
40 cm	10	137.4	182.6	120.8	128.1	568.9	113.8	166.4	143.4	108.8	532.4	550.7
	15	149.5	138.0	127.4	129.6	544.5	140.0	149.3	176.8	137.1	603.2	573.9
	20	165.3	209.4	165.0	167.8	707.5	128.9	224.9	200.7	152.4	706.9	707.2
	25	162.4	203.2	189.5	208.3	763.3	166.9	240.7	165.4	146.2	719.2	741.3
60 cm	10	110.4	184.9	114.2	187.8	597.3	97.5	176.7	108.6	119.4	502.2	549.8
	15	164.1	167.8	124.1	147.1	603.1	138.1	179.2	150.9	165.3	633.5	618.3
	20	133.9	167.6	164.6	184.8	650.9	166.9	186.7	159.9	144.5	658.0	654.5
	25	145.9	188.6	192.1	166.0	692.6	161.9	221.1	162.7	152.6	698.3	695.5
LSD at 0.05		10.14	10.66	11.20	10.60	45.80	10.43	14.08	11.36	10.73	34.29	42.40

CONCLUSION

From the obtained results it could be concluded that, under sandy soil of Ismailia Governorate, fodder pearl millet is a successful fodder crop and higher fresh, dry and crude protein yields could be achieved by planting in rows 20 cm apart and using 25 kg seeds/fed as a seeding rate which reflected positively on the yield quantity and quality of fodder pearl millet under sandy soil of Ismailia circumstances.

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تأثير مسافات الزراعة ومعدلات التقاوى على الانتاجية والجودة لمحصول دخن العلف تحت ظروف الأراضى الرملية

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أجريت هذه الدراسة بمحطة بحوث الإسماعيلية التابعة لمركز البحوث الزراعية خلال الموسمين الزراعيين ٢٠٠١ ، ٢٠٠٢ وذلك لدراسة تأثير ثلاث مسافات للزراعة وهى ٢٠، ٤٠، ٦٠ سم بين السطر والأخر وأربعة مستويات مختلفة لمعدلات التقاوى (١٠، ١٥، ٢٠، ٢٥ كجم / للفدان) على إنتاجية وجودة محصول دخن العلف. وكان تصميم التجربة قطع منشقة فى أربع مكررات. احتلت مسافات الزراعة القطع الرئيسية ومعدلات التقاوى القطع المنشقة. وكانت النتائج المتحصل عليها كالتالى:

١- لا يوجد اختلاف معنوى عند تطبيق مسافات الزراعة ٤٠ أو ٦٠ سم بين السطور على إنتاجية المحصول الأخضر والجاف وحاصل البروتين.

٢- استخدام ٢٠ سم كمسافة بين السطور أعطت أعلى إنتاجية للمحصول الأخضر والجاف وحاصل البروتين فى كلا الموسمين وأيضا التحليل التجميعى لهم.

٣- بزيادة معدلات التقاوى إلى ٢٥ كجم للفدان يزداد إنتاجية دخن العلف سواء المحصول الأخضر أو الجاف بالإضافة إلى محصول البروتين.

٤- هناك استجابة معنوية لتأثير التفاعل بين مسافات الزراعة ومعدلات التقاوى على الإنتاجية والجودة لدخن العلف وخاصة عند استخدام ٢٠ سم كمسافة بين السطور ومعدل تقاوى ٢٥ كجم للفدان.