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Growth and Fodder Yield of Forage Pearl Millet in Newly Cultivated Land as Affected by Date of Planting and Integrated use of Mineral and Organic Fertilizers

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ABSTRACT

This research was undertaken to determine the effect of sowing dates and integrated use of inorganic and organic fertilizers on growth and forage yield of pearl millet (*Pennisetum glaucum* (L.) R. Br.), in newly cultivated land. The experiment was conducted at the experimental farm Faculty of Agriculture, South Valley University at Qena Governorate, Egypt, during the years 2009 and 2010. Three sowing dates viz., D_1 (15-April), D_2 (15-May) and D_3 (15-June) were assigned to main plots. Five combination inorganic and organic fertilizers viz. T_1 (recommended NPK; 180:55:60 kg ha^{-1}), T_2 (20 tons FYM ha^{-1}), T_3 (25% of NPK + 15 tons FYM ha^{-1}), T_4 (50% of NPK +10 tons FYM ha^{-1}) and T_5 (75% of NPK + 5 tons FYM ha^{-1}) were assigned to sub plots. Results revealed that growth parameters and forage yield were significantly affected by the sowing dates and fertilization treatments. Crude protein content was unaffected by sowing date. The interaction of sowing dates and fertilization treatments significantly affected on number of tillers $plant^{-1}$, LA and green and dry forage yields ha^{-1}. Pearl millet sown at 15-May (D_2) and application of 75% of NPK + 5 tons FYM ha^{-1}(T_5) gave the highest values of green and dry forge yields ha^{-1}, while the lowest were found for D_3T_2. Thus, a sowing date at mid-May with integrated use of mineral and organic fertilizers (75% of NPK + 5 tons FYM ha^{-1}) is recommended for forage pearl millet under the conditions of this study.

Key words: Forage pearl millet, sowing dates, cutting, green fodder, crude protein

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is commonly grown in the arid and semiarid regions of Africa and India as a stale food for millions of people and its grain is most likely to be used for animal feed and forage crop. It is particularly adapted to nutrient poor soil and low rainfall conditions (Ali, 2010). The grain is used to make unleavened bread (chapattis) in South Asia and prepared as gruel, dumplings, couscous and beer in Africa. In Egypt, pearl millet has been grown mainly as a forage crop in summer season. Many dairy farmers consider it superior to other pastures for milk production and farmers producing beef are using it to good advantage because the mean hydrocyanic acid potential (HCN-P) values for the crop are very low as compared with sorghum and sorghum-sudan grass hybrids. The ability to reliably produce on marginal lands and under low rainfall conditions (Menezes *et al*., 1997) makes pearl millet an attractive choice for the sandy, low fertility soils of the Egypt.

Managing planting date influences crop growth and development as well as the interaction between growth and development and stressful periods. In central Punjab irrigated millet (used primarily for fodder) is grown from May to July. In Sindh, millet for fodder may be grown from

February to July, but for grain production, sowing is delayed to June-July to avoid flowering in July-August when the temperatures are extremely high (Pakistan Agriculture Research Council, 2006). Hanna and Wright (1995) looked at the effects of planting date on three hybrids of pearl millet differing for maturity and rust resistance. Date of planting was significant for both height and yield with June plantings having lower yields than May plantings. Much of this yield reduction was attributed to rust susceptibility as rust inoculums become more prevalent later in the season (Wilson *et al*., 1995). Maas *et al*. (2007) found that yields tended to decline from April through June and then significantly decreased when plantings were in July or August (in 2001). Yield in 2002 increased from April through June and then declined for the later planting dates. Meanwhile, M'Khaitir and Vandelrlip (1992) reported that pearl millet yield no significant response to planting date. Plant crude protein and fiber were not affected by sowing date (El-Hattab and Harb, 1991). Limited literature is available for deducing the influence of sowing time on fodder quality. The available literature suggests that it has limited influence. However, for maximizing fodder yields, the appropriate sowing date which creates optimal growing conditions for the crop and also reduces the risk of pest and disease attack should be chosen.

There is increased emphasis on the impact on environmental quality due to continuous use of chemical fertilizers. The integrated nutrient management system is an alternative and is characterized by reduced input of chemical fertilizers and combined use of chemical fertilizers with organic materials such as animal manures, crop residues, green manure and composts (Chen, 2006). Based on the evaluation of soil quality indicators, Dutta *et al*. (2003) reported that the use of organic fertilizers together with chemical fertilizers, compared to the addition of organic fertilizers alone, had a higher positive effect on microbial biomass and hence soil health. Application of organic manure in combination with chemical fertilizer has been reported to increase absorption of N, P and K in sugarcane leaf tissue in the plant and ratoon crop, compared to chemical fertilizer alone (Bokhtiar and Sakurai, 2005). The periodically furnishing sandy soils with organic manure could help in decreasing crop mineral fertilizer requirements (Asker *et al*., 1994; Shabayek, 1997). Improved fodder pear millet varieties and hybrids respond well to nutrient application. However, unless the nutrients are replenished, higher yields cannot be expected from the succeeding crop. Integrated use of inorganic and organic fertilizers should be employed to maximize economic yield and to improve soil health (Ismail *et al*., 2001). The importance of the use of organic sources of nutrients along with chemical fertilizers for maintaining soil health has been emphasized by Katyal (2000).

This is an attempt to study the impact of sowing date and integrated use of inorganic and organic fertilizers on growth and forage yield of pearl millet under newly cultivated land.

MATERIALS AND METHODS

Experimental site description: The investigation was undertaken at experimental farm Faculty of Agriculture, South Valley University at Qena Governorate (26° 10'N, 32° 43'E and 79 m above mean sea level), Egypt, for two seasons during summer 2009 and 2010. The soil of the experimental site is sandy throughout its profile (73.9% coarse sand, 16.7% fine sand, 5.7% silt and 3.7% clay). Its pH value of 7.52, 1.85 EC (dS m^{-1}), 0.42% organic matter content, 0.23% total N, and available P and K of 7.32 and 168 ppm, respectively.

Experimental treatments and design: Seeds pearl millet cultivar Shandaweel 1 (24 kg ha^{-1}) were hand sown as the usual dry method of sowing on one side of ridges (50 x 15 cm). The treatments consisted three dates of sowing viz., D_1 (15-April), D_2 (15-May) and D_3 (15-June) and

five combination inorganic and organic fertilizers viz., T_1 (recommended NPK; 180:55:60 kg ha^{-1}), T_2 (20 tons FYM ha^{-1}), T_3 (25% of NPK + 15 tons FYM ha^{-1}), T_4 (50% of NPK + 10 tons FYM ha^{-1}) and T_5 (75% of NPK + 5 tons FYM ha^{-1}). The experiment was laid out in randomized complete block split plot design with three replications keeping sowing date in main plot and fertilizers treatments in sub plot. Individual sub plots measured 3.0 m in width and 7 m in length.

The chemical fertilizers were applied in the forms of ammonium nitrate (33.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (50% K_2O). Nitrogen was applied in three equal splits for three cuttings. Calcium superphosphate and potassium sulphate were applied at sowing time. Farm yard manure (FYM) was added during seedbed preparation. The chemical FYM properties were 7.77 and 7.80 pH values, 16.02 and 15.85% organic carbon, 2.45 and 2.52 E.C dS m^{-1}, 0.72 and 0.74% total N, 0.24 and 0.25% total P and 1.27 and 1.26% total K, in first and second seasons, respectively. The other agronomic practices were kept normal and uniform for all the treatments.

Parameter assessments: The plants were harvested at 05 to 10% heading in each cut at about 10 cm above the ground at both years. At each cut agronomic traits such as main stem height, total tillers number per plant, total leaves number per plant and leaf area (LA) per plant were determined from a minimum of ten randomly sampled plants from each sub plot. Total fresh forage yield was also determined immediately after harvest in the field from the three central rows of each sub plot in each cut. Then the plant materials were separated into leaves and stems, dried at 75°C for 48 h and weighed. Crude protein was determined according to the AOAC (1990) methods.

Statistical analysis: Data of each season were subjected to analysis of variance and the test of homogeneity of variance was done (Bartlett's test of homogeneity) and the combined analysis of both seasons, as described by Gomez and Gomez (1984). The least significant difference (LSD) test at 0.05 levels was used to compare among means of treatments.

RESULTS AND DISCUSSION

Growth parameters: The growth parameters, namely plant height, number of tillers $plant^{-1}$, number of leaves $plant^{-1}$ and LA $plant^{-1}$ are presented in Table 1. Both the sowing dates and fertilization treatments significantly affected all growth parameters. Planting date at D_2 (15-May) demonstrated highest values for all growth parameters followed by planting at D_1 (15-April). In the first cut, D_2 increased plant height by 6.8 and 9.1%, number of tillers $plant^{-1}$ by 11.3 and 24.2%, number of leaves $plant^{-1}$ by 19.8 and 40.8% and LA $plant^{-1}$ by 14.7 and 23.0% over D_1 and D_3, respectively. These findings are in close conformity with Hanna and Wright (1995) found that date of planting was significant for both height and yield with June plantings having lower yields than May plantings.

As seen from Table 1, crop fertilized at 75% NPK + 5 t FYM ha^{-1} (T_5) produced the tallest plant (145.3, 151.4 and 145.6 cm at the 1st, 2nd and 3rd cuttings, respectively), maximum number of tillers (12.89, 16.50 and 20.06) and leaves (10.11, 10.72 and 9.49) per plant and heights LA (19.22, 18.39 and 15.56 dm^2). In all growth parameters and cuttings, the differences between T_1 (recommended NPK) and T_4 (50% NPK + 10 t FYM ha^{-1}) treatments were non-significant. In general, applied of T_5 (75% NPK + 5 t FYM ha^{-1}) significantly superiority over T_1 (recommended NPK) or T_2 (20 t FYM ha^{-1} alone) of the aforementioned traits. These increases in growth traits appeared to be more obvious when the FYM was mixed with the mineral NPK fertilizers as

Table 1: Growth parameters of pearl millet as affected by sowing date and fertilization treatments (data over two years 2009 and 2010)

	Plant height (cm)			No. of tillers plant^{-1}			No. of leaves plant^{-1}			LA plant^{-1} (dm2)		
Treatments	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Sowing date (D)												
D_1:15April	133.3	14.09	135.4	10.27	14.00	17.43	8.07	8.77	7.58	15.87	15.87	12.07
D_2:15 May	142.3	14.71	143.3	11.43	15.03	18.83	9.67	9.99	8.80	18.20	17.60	14.07
D_3:15 June	130.4	139.1	132.4	9.20	12.80	16.17	6.87	7.63	6.33	14.80	16.03	11.80
LSD 0.05	7.1	5.7	6.2	1.02	0.99	1.24	1.10	1.13	1.21	2.23	1.17	1.63
Fertilization (T)												
T_1	137.6	143.7	137.9	10.67	14.61	17.94	8.44	9.28	7.82	16.33	16.72	13
T_2	124.1	133.4	128.9	7.89	11.22	14.94	6.22	6.6	5.34	14.67	15.39	10.44
T_3	132.7	138.4	134.1	9.5	13.17	16.56	8.11	8.11	7.71	14.78	15.17	11
T_4	137	144.7	138.8	10.56	14.22	17.89	8.11	9.28	7.49	16.44	16.83	13.22
T_5	145.3	151.4	145.6	12.89	16.5	20.06	10.11	10.72	9.49	19.22	18.39	15.56
LSD 0.05	5.6	5.0	5.7	0.9	0.88	0.84	1.37	0.98	1.18	1.36	0.95	1.57
D x T	ns	ns	ns	*	*	*	ns	ns	ns	**	**	**

Fertilization treatments (T): T_1 (recommended NPK; 180:55:60 kg ha^{-1}), T_2 (20 tons FYM ha^{-1}), T_3 (25% of NPK + 15 tons FYM ha^{-1}), T_4 (50% of NPK + 10 tons FYM ha^{-1}) and T_5 (75% of NPK + 5 tons FYM ha^{-1}). * and ** Denotes significance at 0.05 and 0.01 probability levels, respectively. ns: Not significant

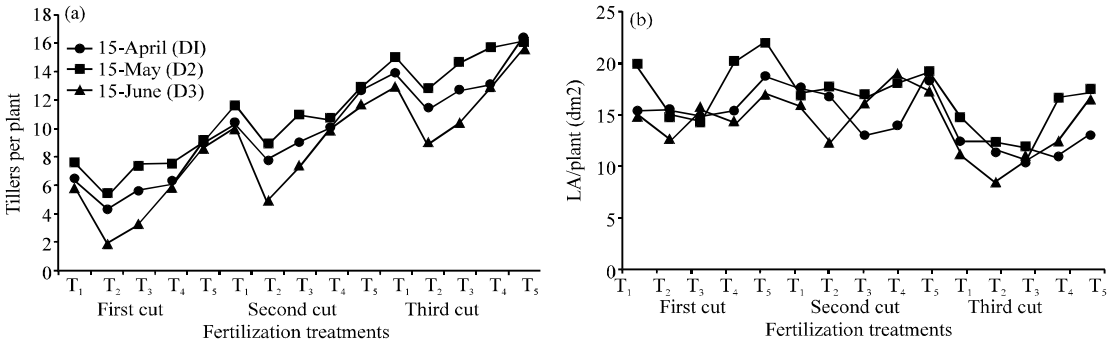

Fig. 1: (a, b) Interaction effect between sowing dates and fertilization treatments on tillers and LA per plant

compared to the FYM or 100% NPK mineral fertilizers. It can be due either to the effect of FYM and mineral NPK fertilizers on improving soil physical properties, or to a higher mineralization of FYM which it due to mineral NPK inputs. It increased plant availability of macro- and micronutrients which led to high vegetative growth and more absorption of NPK. These results are in agreement with Bilal *et al.* (2000) found that in mott grass (*Pennisetum purpureum*) plant height and number of tillers/plant increased significantly with N or FYM application over control at all growth stages in all cuttings.

The interaction between sowing date and fertilization treatments had a significant effect on tillers and LA plant^{-1} at all cuttings as presented in Table 1. Figure 1 indicated that the largest of tillers (9.00, 13.00 and 16.17 at three cuttings) and LA plant^{-1} (22.00, 19.00 and 17.00 dm^2) were obtained when pearl millet planted at 15 May (D_2) and applied 75% NPK + 5 t FYM ha^{-1} (T_5). Meanwhile, the lowest values of tillers (2.00, 5.00 and 8.83) and LA plant^{-1} (12.67, 12.17 and 8.33 dm^2) were obtained at D_3T_2 (sowing at 15 June and applied 20 t FYM ha^{-1}).

Fodder yield: Sowing date had a pronounced effect on green and dry fodder yields under 1st cut, 2nd cut and 3rd cut (Table 2). At all cuttings, a fodder yield was significantly higher in D_2 compared

Table 2: Forage yield and crude protein of pearl millet as affected by sowing date and fertilization treatments (data over two years 2009 and 2010)

	Green forage yield (t ha^{-1})			Dry matter (t ha^{-1})			Crude protein content (%)		
Treatments	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Sowing date (D)									
D_1:15April	18.66	22.329	13.553	3.345	3.908	2.371	8.31	7.37	7.41
D_2:15 May	20.94	24.122	16.115	3.992	4.478	2.771	9.06	7.97	7.46
D_3:15 June	16.89	18.884	11.222	2.848	3.4	1.956	9.61	7.95	7.54
LSD 0.05	1.667	1.765	1.871	0.421	0.454	0.374	ns	ns	ns
Fertilization (T)									
T_1	19.68	22.46	13.769	3.61	3.997	2.541	9.34	8.33	7.72
T_2	14.81	17.294	10.291	2.413	2.995	1.738	7.53	6.7	6.38
T_3	16.41	19.577	11.794	2.949	3.397	1.88	7.67	6.83	6.42
T_4	20.19	22.751	14.974	3.613	4.145	2.611	9.5	8.19	7.73
T_5	23.07	26.81	17.322	4.388	5.109	3.06	10.65	9.6	9.12
LSD 0.05	1.467	1.667	1.554	0.402	0.36	0.35	1.07	0.97	1.1
D x T	**	**	**	**	**	**	ns	ns	ns

Fertilization treatments (T): T_1 (recommended NPK; 180:55:60 kg ha^{-1}), T_2 (20 tons FYM ha^{-1}), T_3 (25% of NPK + 15 tons FYM ha^{-1}), T_4 (50% of NPK+10 tons FYM ha^{-1}) and T_5 (75% of NPK+5 tons FYM ha^{-1}). **Denote significance at 0.01 probability levels. ns: Not significant

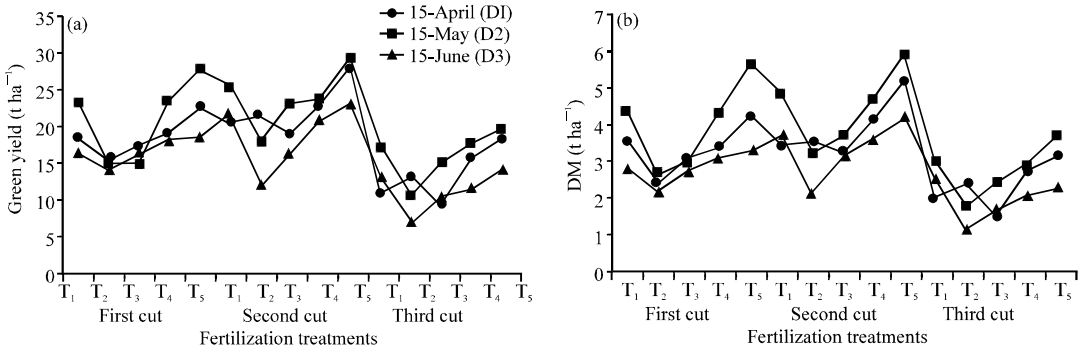

Fig. 2: (a, b) Interaction effect between sowing dates and fertilization treatments on green and DM yields t ha^{-1}

with the other sowings and it was lowest in D_3 (15-June). Planting at 15 May (D_2) significantly increased green fodder yield by 12.2 and 24.0% in the first cut, 8.0 and 27.7% in the second cut and 18.9 and 43.6% in the third cut compared to planting at 15-April (D1) and 15-June (D_3), respectively. Also, this treatment significantly increased dry fodder yield by 19.3 and 40.2% in the first cut, 14.6 and 31.7% in the second cut and 16.9 and 41.7% in the third cut compared to D_1 and D_3, respectively. These results were in line with those of Maas *et al.* (2007). On contrary, M'Khaitir and Vandelrlip (1992) reported that pearl millet yield no significant response to planting date.

Significant differences in the green and dry yields were observed due to fertility variation (Table 2). Like growth parameters, higher fodder yield was recorded in the treatments received 5 tones of FYM along with 75% recommended dose of NPK (T_5) than the other treatments. Average green yield increases for T_5 (75% NPK+5 t FYM ha^{-1}) relative to T_1 (NPK) and T_2 (20 t FYM) were 17.2 and 55.8% in the first cut, 19.4 and 55.0% in the second cut and 25.8 and 68.3% in the third

cut, respectively. Also, dry yield increases for T_5 relative to T_1 and T_2 were 21.6 and 81.8% in the first cut, 27.8 and 70.6% in the second cut and 20.4 and 76.1% in the third cut, respectively. This increased in fodder yield with combined application of FYM and inorganic fertilizers might be due to better availability for nutrients at the root zone when compared to only recommend NPK or FYM applied plots. Singh *et al.* (1981) observed that, under the arid conditions, continuous application of sheep manure in general gave substantially higher pearl millet yields than the application of urea alone. Rao *et al.* (2007) found that application of 5 t FYM/ha+50% recommended dose of mineral fertilizer significantly increased green and dry fodder yields of sorghum by 35.1 and 35.7% over the control. Combined application of FYM and inorganic fertilizer could have created a favorable physical environment for the increased available N resulting in mineralization and availability of nutrients and as noticed by improvement in uptake of nutrients (Anonymous, 2000). The combined effect of sowing date and fertilization treatments had a significant effect on the green and dry yields in three cuttings (Table 2). Figure 2 indicated that the highest values for green yield (27.762, 29.540 and 19.587 t ha^{-1}) and dry yield (5.660, 5.915 and 3.675 t ha^{-1}) were obtained for D_2T_5 and the lowest for D_3T_2.

Crude protein: Data listed in Table 2 showed that crude protein was not affected by sowing date in all cuttings. Similar results were reported by El-Hattab and Harb (1991).

Plant crude protein was significantly affected by fertilization treatments in all cuttings (Table 2). The treatments received T_5 significantly higher crude protein than other fertilization treatments. The lowest values for crude protein (7.53, 6.70 and 6.38%) were obtained for T_2 and the highest (10.65, 9.60 and 9.12%) for T_5. These increases with integrated use of mineral and organic fertilizers may be improving the nutrient up-take including nitrogen nutrient and also phosphorus being component of ATP the energy carrier for the metabolic processes. This might have directly contributed to large photosynthetic activity and synthesis of higher protein content. Similar results were found by Patidar and Mali (2004) and Ganai *et al.* (2010).

The interaction effect of sowing date x fertilization was not significant for crude protein in all cuttings.

CONCLUSION

Generally it can be concluded that forage Pearl millet sown at 15-May and application of 75% of recommended NPK+5 tons FYM ha^{-1} gave the highest values of green and dry forge yields ha^{-1}. Thus, a sowing at mid-May with integrated use of mineral and organic fertilizers is recommended for forage pearl millet under the conditions of this study.

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