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GROWTH AND FORAGE YIELD OF PEARL MILLET AS INFLUENCED BY CUTTING DATE AND NITROGEN FERTILIZATION

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ABSTRACT: This investigation was conducted at the, Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt during 2016 and 2017 summer seasons to study the growth and forage yield of Pearl millet. The experiment was arranged in a split plot design with three replications. The treatments consisted of two cutting dates [early at 56 days after sowing (DAS), and late at 63 DAS for the 1st cut, and after 35 and 42 days from the 1st and 2nd cuts for the 2nd and 3rd cuts] respectively and three nitrogen (N) fertilizer levels *viz*. 15, 30 and 45 kg N/fad./cut. The results indicated that late cutting date significantly produced the highest growth values for each of plant height (238.2 cm), leaf area/plant (4970.2 cm^2) and fresh forage weight (164.9 (g)/plant). Also, the highest fresh and dry forage yields (16.88 and 3.541 ton/fad), the highest total fresh seasonal yield (TFSY) and total dry seasonal yield (TDSY) 37.98 and 7.11 ton/fad., were as well recorded by late cutting in both seasons. Apparently**,** the highest obtained value of each studied growth traits and the forage yield during both growing seasons was achieved by increasing N fertilizer level up to the highest amount (45 kg N/fad./cut), followed by 30 and 15 kg N/fad./cut, respectively. The significant interaction effect between the two studied factors on forage yield indicated that the highest (TDSY) (7.607 ton/fad.) of pearl millet was obtainable at late cutting date under application of 45 kg N/fad./ cut. The results of the present study has concluded that, cutting at 63 DAS followed by 42 and 35 days interval for next cuts (three cuts) with application of 45 kg N/fad./cut is optimum for better growth and yield performance in pearl millet cultivar "Shandaweel 1" under the agro-climatic conditions of Sharkia Governorate in Egypt and similar areas.

Key words: Pearl millet, cutting date, nitrogen level, growth, forage yield.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) is an important and widely cultivated staple crop in many African countries. It provides a dual-purpose annual summer crop utilized for human food and livestock feeding. The crop is well knowable by forage producers especially in arid and semi-arid areas for its heat and drought tolerance, vigorous growth, quick re-growth after grazing or cutting, high biomass production potential and free from hydrocynide acid (**Khairwal *et al*., 2007; Bramhaiah *et al*., 2018**). Pearl millet's green foliage is leafy, palatable and nutritious feedstock for dairy cattle. Today in Egypt, with the continues occurrence of green forage shortage during summer seasons, increasing the productivity of some promising annual forage types is getting interest. Growth and yield of pearl millet can be enriched only through efficient agronomy intervention. Forage cutting date was found to be a determinant factor that affect to a great extend the regrowth habit as well as yield of forage crops. It was established that early cutting would trigger crop re-growth, while delayed cutting tend to produce higher yield (**Bukhari *et al*., 2011; Raval *et al*., 2014; Manjanagouda, 2015**). In this context, **Andrews and Kumar (1992)** stated that pearl

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millet suitability for harvest depends on plant development stage among other factors, indicating that cutting pearl millet at heading stage with stubble height of 15 cm. will produce the highest digestible palatable yield in addition to fastest re-growth. **Soliman (2000)** found that the highest total fresh and dry forage yields of pearl millet cultivar Shandaweel 1 were obtained by cutting the crop at 50 DAS. **Wadi *et al.* (2004)** reported that the dry yield of pearl millet was higher in plants cut at 90 DAS than 60 DAS, respectively. Results obviously indicated that pearl millet dry yield increases at late cutting dates. **Bukhari *et al*. (2011)** stated that maximum leaf area was noticed when pearl millet was cut at 75 DAS compared to cutting at 45 and 60 DAS. Also **Shahin *et al*. (2013)** reported that the tallest plants (127.15 cm) of forage pearl millet cultivar Shandaweel 1 were obtained at the first cut compared to advanced cuts. **Noor *et al.* (2016)** indicated that pearl millet cutting *viz*. 55, 65 and 75 DAS gave the maximum plant height (cm) and maximum leaf area per plant (cm^2) at 75 DAS. **Eissa *et al*. (2018)** concluded that pearl millet forage crop's, plant height and leaf area per plant gave the highest significant values at the 1st cut, then gradually decreased till reached the lowest values at the 3rd cut, respectively. Further, **Chaudhari *et al*. (2018)** found no significant effect on plant height of pearl millet at 30 DAS but the significant effect was observed at 60 DAS, which provided higher plant height. Identifying the pearl millet most suitable cutting date is therefore decisive for insurance of timely crop regrowth after cutting or grazing and to obtain high forage yield. Often, farmers and forage producers be likely to decide harvesting forage crops based on the market demand neglecting the most suitable cutting date at which better growth and higher yield are obtained. Plant nutrition elements particularly nitrogen are essential for increasing crops productivity. It drives the vegetative growth and maximizes yield of forage crops of the grass family (**Usofzadeh *et al*., 2013; Midha *et al*., 2015; Nirmal *et al*., 2016; Joshi *et al*., 2018; Thakor *et al*., 2018**). Whilst, nitrogen is considered a limiting factor to forage crop production under Egyptian soil conditions (**FAO, 2005; Mahmoud *et al*., 2017; Mansour *et al*., 2017**). **Ayub *et al.* (2009)** reported that, plant height of pearl millet (*Pennisetum americanum* L.) was significantly affected by nitrogen application and produced the tallest plants (199.87 cm) with applying 180 kg N ha^{-1}. **Shahin *et al*. (2013**) reported that pearl millet cultivar Shandaweel 1 recorded significantly the tallest plants and the highest fresh forage yield (17.63 t ha^{-1}) by application of 75 kg ha^{-1} of nitrogen fertilizer. **Prasad *et al.* (2014)** found that the tallest plants (159.86 cm) of pearl millet was obtained with application of 60 kg N ha^{-1} compared to lower N levels. Further, **Ibrahim *et al.* (2014)** revealed significant effects on fresh forage weight, dry weight and forage yield of pearl millet with increased N fertilizer levels from 40 up to 160 kg N ha^{-1}. **Sheoran *et al.* (2016)** reported that the increment of N levels from 0 up to 90 kg N ha^{-1} significantly increased the green fodder yield of pearl millet (*Pennisetum glaucum* L.) over lower levels. **Serba and Obour (2017)** also concluded that nitrogen fertilizer application increased forage yield of pearl millet with (30 lb/acre) as adequate for high forage production. **Thakor *et al.* (2018)** reported higher values of yield attributes in summer pearl millet at the higher-level of 120 kg N/ha compared to 80 and 100 kg N/ha. **Kumawat *et al.* (2017)** confirmed similar results on growth characters and yield of pearl millet using of the highest N level 90 kg N ha^{-1} compared to 30 and 60 kg N ha^{-1} respectively. **Bramhaiah *et al.* (2018)** stated that fodder pearl millet produced the tallest plants by the application of the maximum N level (150 kg N ha^{-1}) compared to lower levels.

In the light of that background, the present investigation was carried out with the aim to determine the most suitable cutting date and optimum nitrogen (N) fertilizer level that can bring about better growth and higher forage yield in pearl millet cultivar Shandaweel 1 under the agro-climatic conditions of Sharkia Governorate, Egypt.

MATERIALS AND METHODS

Two field experiments were conducted during two consecutive summer seasons 2016 and 2017 on a clay soil at the Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt (30º 6` N and 31º 6` E). Soil samples from (30 cm) depth were taken to determine the soil physical and chemical properties (Table 1). In addition,

Table 1. Physical and chemical properties of soil at the experimental site

Characteristic	Value
Soil particles distribution	
Sand (%)	17.45
Silt (%)	22.70
Clay (%)	59.85
Soil texture	clay
pH (1: 2.5 soil-water suspension)	7.23
Soluble cations and anions (mmolc $^{L-1}$) *	
Calcium (Ca^{++})	5.0
Magnesium (Mg^{++})	5.5
Carbonate ($CO_3^{=}$)	-
Bicarbonate (HCO_3^{-})	0.50
Chlorine (Cl^{+})	6.00
Sulphate ($SO_4^{=}$)	11.10
Available nutrient (mg kg^{-1} soil)	
Total N (%)	0.08
Available P (ppm)	9.08
Potassium (K)	0.10

meteorological data *i.e.* averages of minimum, maximum air temperatures and relative humidity during the growing period (from April to September in first and second seasons) are presented in (Table 2). Treatments consisted of two cutting dates (early and late) and three nitrogen levels (15, 30 and 45 kg N/fad./cut) using a Pearl millet cultivar Shandaweel 1. The early cutting date in the 1st cut was taken 56 DAS, and the late cutting was taken 63 DAS. The early and late cuttings dates in 2nd cut were taken after 35 and 42 days from the 1st cut, and same schedule was done for the 3rd cut, respectively. The experiments were laid out in a split plot design with three replications, where cutting dates assigned to the main plots and nitrogen fertilizer levels occupied the sub plots. The preceding crop was faba bean (*Vicia faba* L.) during both seasons. Grains of pearl millet Shandaweel 1 were sown on April 28th and May 20th in the first and second seasons, respectively. Sowing was done in hills on ridges, with 10 cm distance between hills and 60 cm between ridges. The experimental plot area was 10.5 m^2, (*i.e.* 2.5 m width and 4.2 m length), each plot contained 7 ridges. Thinning was done at 14 DAS leaving two plants per hill to obtain a population of 140.000 plants/fad. Nitrogen fertilizer was applied in form of Ammonium nitrate (33.5% N), while weed control was done manually. A surface irrigation system was used and the other culture practices for the crop were applied according to ministry of agriculture recommendations.

Recorded Data

Growth characters

In order to measure the studied growth characters, five guarded plants were randomly taken from the 2nd and 6th ridges of each plot, respectively.

Table 2. Air temperatures (°C) and relative humidity (%) during the two growing seasons at the experimental site

	Temperature (° C)			Humidity (%)		
			2016 season			
Month	Min.	Max.	Avg.	Min.	Max.	Avg.
May	20.8	32.9	26.9	9.3	21.4	15.4
June	24.2	36.7	30.5	8.9	22.7	15.8
July	24.8	35.1	30.1	4.1	27.8	15.9
Aug	25.1	35.0	30.1	3.8	28.2	16.0
Sep	23.6	33.4	28.4	3.9	26.8	15.4
			2017 season			
Month	Min.	Max.	Avg.	Min.	Max.	Avg.
May	20.2	31.8	26.0	10.0	24.2	17.1
June	23.4	35.2	29.3	7.5	26.1	16.8
July	25.5	35.4	30.1	5.5	29.2	17.4
Aug	25.6	35.1	30.5	3.2	28.7	15.9
Sep	23.3	31.2	27.3	3.6	28.2	15.9

The vegetative measurements

Vegetative traits included plant height (cm), number of shoots per plant, leaf area per plant (cm^2) which was calculated using the following equation (length × maximum width × 0.72 × number of leaves per plant) and fresh forage weight per plant (g).

Forage yield

Fresh forage yield was estimated by harvesting the plants of the inner three ridges at each plot, weighted in (kg/plot), then converted into (ton/ fad.) using the plot and the dry yield (ton/fad) was determined in lab using a (500 g) sub-sample collected from the fresh weights, oven dried at constant temperature of 70°C for 48 hours accordingly.

Statistical analysis

Data of the two seasons were statistically analyzed according to the methods outlined by **Steel *et al.* (1997)**. Whereas, significance of differences among various means of different characters under study was compared with the help of Duncan's multiple range tests **(Duncan, 1955)**. In the interaction Tables, capital and small letters were used for comparison among row and column means, respectively.

RESULTS AND DISCUSSION

Growth Characters

Plant height (cm), number of shoots/plant, leaf area (cm^2)/plant and fresh forage weight (g)/ plant

Results revealed in Table 3 show the influence of cutting dates and nitrogen fertilization levels on plant height in both seasons. It is evident from Table 3 that plant height was significantly affected by cutting date in both seasons. The late cutting date (63 DAS), (42 days after 1st cut) and (42 days after 2nd cut) appeared to produce the tallest plants (183.3, 238.2 and 167.9 cm) in the first season during the three cuts, compared to early cutting. Meanwhile in the second season, the differences between cutting date treatments (early and late) for the second cut did not reach the level of significance. While, the early cutting date (35 days after 2nd cut) gave the highest plant height value (129.4 cm.) at the 3rd cut in second season compared with that of late cutting date (115.0 cm.) in the same cut (42 days after 2nd cut). Number of shoots/ plant is an important yield contributing parameter and has direct effect on both fresh and

Table 3. Effect of cutting date and nitrogen fertilizer levels on plant height (cm), number of shoots per plant, leaf area, fresh forage weight per plant of pearl millet during 2016 and 2017 seasons

Main effects and interaction	Plant height (cm)			Number of shoots/ plant			Leaf area (cm^2)/plant			Fresh forage weight (g)/ plant		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Cutting date (D)					**2016 season**							
Early	138.3 b	179.8 b	147.1 b	3.211 b	5.278 a	3.233 a	4041.6 b	1315.7 b	1313.1 b	157.7	213.7	99.44
Late	183.3 a	238.2 a	167.9 a	6.322 a	4.678 b	0.840 b	4970.2 a	3837.5 a	1716.9 a	219.8	220.4	101.2
F. test	**	**	*	**	*	**	**	**	**	NS	NS	NS
Nitrogen level (N): kg N/fad/cut												
15	141.8 c	175.3 c	140.8 b	3.917 c	4.283 c	1.950 b	3778.8 c	1907.1 c	1154.5 c	137.6	185.2 b	11.43
30	160.4 b	217.3 b	162.7 a	4.650 b	4.967 b	2.072 a	4780.1 b	2710.8 b	1681.2 b	179.1	199.6 b	11.86
45	180.1 a	234.2 a	169.1 a	5.733 a	5.683 a	2.088 a	4958.8 a	3112.0 a	1709.3 a	249.5	266.3 a	11.93
F.test	**	**	**	**	**	*	**	**	**	NS	*	NS
Interaction D x N	NS	NS	NS	*	NS	**	**	**	**	NS	NS	NS
Cutting date (D)					**2017 season**							
Early	104.2b	121.1	129.4 a	1.811	1.8	1.000 a	2718.7 b	2242.7 a	1619.2 a	91.22 b	136.7 b	92.51 a
Late	112.3a	143.8	115.0 b	1.878	1.833	0.611 b	3267.0 a	2233.3 b	1251.8 b	124.7 a	164.9 a	80.47 b
F.test	**	NS	**	NS	NS	**	**	**	**	**	**	*
Nitrogen level (N) : kg N/fad/cut												
15	101.7 c	101.4 b	112.2b	1.383 c	1.350 c	0.667 c	2506.0 c	1667.0 c	1173.4 c	92.23 b	128.4 b	83.37 b
30	109.6 b	141.3 a	124.1a	1.867 b	1.700 b	0.833 b	3051.9 b	2246.1 b	1440.3 b	115.1 a	162.1 a	86.43 ab
45	113.4 a	154.7 a	130.1a	2.283 a	2.400 a	0.917a	3420.6 a	2800.9 a	1692.8 a	116.5 a	161.9 a	89.67 a
F.test	**	**	**	**	**	**	**	**	**	**	**	*
Interaction D x N	NS	NS	NS	**	*	**	**	**	**	NS	NS	NS

*,** and NS indicates significance at 0.05 and 0.01 levels and not significant, in respective order.

total forage yield/fad of pearl millet, wherein the late cutting date (63 DAS) produced the highest number of shoots/ plant (6.32) in the 1st cut followed by (5.27 and 3.23 shoots) in the 2nd and 3rd cuts of early cutting dates (42 days after 1st cut and 2nd cut) in the first season, respectively. It was clear from these results that number of shoots/plant took a reverse direction as the early cutting dates gave higher values compared to late cutting for the 2nd and 3rd cuts, respectively (Table 3). Otherwise, in the second season, differences between cutting dates treatments did not reach the level of significance during the 1st and 2nd cuts. Whereas, in the 3rd cut, early cutting date (35 days after 2nd cut) gave the highest number of shoots per plant (1.00) followed by (0.61) at late cutting date (42 days after 2nd cut). The results of cutting date revealed highly significant differences through both growing seasons with regard to leaf area/plant under the three cuts, where, late cutting (63 DAS), (42 days after 1st cut) and (42 days after 2nd cut) achieved the highest leaf area/ plant values (4970.2, 3837.5 and 1716.9 cm^2) during the first season in the 1st, 2nd and 3rd cuts, respectively, as well as in the 1st cut in second season (3267.0 cm^2) compared to the values obtained at early cutting dates. However, during the second season, a reverse direction was also observed at the 2nd and 3rd cuts whereby the

early cutting dates gave the highest leaf area/ plant (2242.7 and 1619.2 cm^2) compared to that of late cutting (Table 3). Apparently, cutting date had no significant effect on fresh forage weight (g)/plant at all the cuts during the first season (Table 3). Whereas, in the second season, the late cutting date (63 DAS) and (42 days after 1st cut) registered the highest fresh forage weight (g)/plant (124.7 and 164.9 g) in the 1st and 2nd cuts, followed by (92.51 g.) in the 3rd cut under early cutting date (35 days after 2nd cut). Differences between early and late cutting dates were highly significant at the 1st and 2nd cuts, and significant at the 3rd cut accordingly. The highest values obtained for these growth characters during cutting dates could be due to the given extra growing time (7 days after early cutting in the 1st, 2nd and 3rd cuts, respectively) which allowed plants to utilize more nitrogen and nutrients from soil, which resulted in further vegetative growth of the pearl millet crop. These results are in conformity with those reported by **Noor *et al*. (2016) and Eissa *et al*. (2018)**.

Results of the effect of N fertilizer levels indicated highly significant differences throughout the both growing seasons. Mean-through, plant height, number of shoots/plant, leaf area/plant and fresh forage weight (g/plant) appeared to be significantly increased as N level was increased (Table 3). Where, the highest values of aforementioned traits were recorded by the increment of N level up to 45 kg N/fad./cut, followed by 30 and 15 kg N/fad./cut, respectively. However, N level had no significant effect on fresh forage weight (g/plant) in both 1st and 3rd cuts during first season. It was clear from these results that, with the increase in N application, the plant photosynthesizing area, and the assimilate production were increased, therefore caused more plant height, more number of shoots per plant, greater leaf area/plant and thus increased fresh forage weight per plant **(Bramhaiah *et al.*, 2018; Joshi *et al*., 2018; Tisdal and Nelson, 1975)**. Similar significant N effect on vegetative growth characters development in pearl millet were reported by several authors (**Ayub *et al*., 2009; Shahin *et al*., 2013; Ibrahim *et al*., 2014; Bhuva *et al*., 2018; Thakor *et al*., 2018**).

Forage Yield

Fresh and dry yields (ton/fad.)

With regard to the two cutting date treatments, the results obtained under the present investigation revealed significant to highly significant differences between early and late cutting dates over the three cuts, respectively whereby late cutting dates (63 DAS) and (42 days after 1st cut) produced the highest fresh forage yield (ton/fad.) in both growing seasons, as well as, the TFSY (ton/fad.), compared to the early cutting date (56 DAS), (35 days after 1st cut and 2nd cut) (Table 4). The highest fresh forage yield (16.88 ton/fad.) was obtained at the 1st cut late cutting (63 DAS) in the first season, while the lowest yield (3.51 ton/fad.) was recorded at the 3rd cut late cutting (42 days after 2nd cut) in the second season. Additionally, the highest TFSY (37.98 ton/fad.) was recorded at late cutting date in the first season (Table 4) accordingly. However, cutting date had no significant effect on fresh forage yield at the 3rd cut in first season. Furthermore, the late cutting date significantly produced the highest dry forage yield (3.541 ton/fad.) which was recorded at the 1st cut (63 DAS) , followed by (3.183 ton/fad.) at the 2nd cut early (35 days after 1st cut) in the first season. On the other hand, the higher values of dry forage yield were significantly obtained from late cutting dates 3.396 and 2.637 ton/fad for both the 2nd and the 1st cuts compared to early cutting date, respectively (Table 4). Consequently, the highest TDSY (7.113 ton/fad.) was obtained in the late cutting date during second season, followed by 5.223 (ton/fad.) at early cutting date accordingly. However, a reverse direction was yet again observed during the first season at the 2nd cut whereas early cutting date (35 days after 1st cut) outyielded the late cutting date (42 days after 1st cut) and gave the highest dry forage yield (3.183 ton/fad.). Cutting date had no significant effect on TDSY in the first season, as well as, dry forage yield in 3rd cut during the second season. The huge drop witnessed in forage yield (ton/fad.) in the second season compared to the first one, under this study, could be due to variation in sowing time, which was initiated on late April in first season, while

Table 4. Effect of cutting date and nitrogen fertilizer levels on fresh and dry forage yield (ton/fad.) of pearl millet during 2016 and 2017 seasons

Main effects and interaction	Fresh forage yield (ton/fad.)			(TFSY) (ton/fad.)	Dry forage yield (ton/fad.)			(TDSY) (ton/fad.)
	1st cut	2nd cut	3rd cut		1st cut	2nd cut	3rd cut	
Cutting date (D)				**2016 season**				
Early	11.11 b	8.22 b	9.96	29.29 b	2.543 b	3.183 a	0.920 b	6.646
Late	16.88 a	11.16 a	9.94	37.98 a	3.541 a	2.182 b	1.920 a	7.643
F. test	*	**	NS	*	*	*	**	NS
Nitrogen level (N): kg N/fad./cut								
15	11.32 b	5.94 c	3.23 c	20.48 b	3.020	2.110 b	0.955 c	6.085 b
30	14.17 ab	9.47 b	4.05 b	27.68 b	2.990	2.605 b	1.102 b	6.697 ab
45	16.51 a	13.68 a	4.58 a	34.78 a	3.177	3.333 a	1.237 a	7.747 a
F.test	*	**	**	**	NS	**	**	*
Interaction D x N	NS	NS	NS	NS	NS	NS	NS	NS
Cutting date (D)				**2017 season**				
Early	5.40 b	6.01 b	4.06 a	15.56 b	2.214 b	1.984 b	1.024	5.223 b
Late	6.25 a	9.68 a	3.51 b	19.44 a	2.637 a	3.396 a	1.080	7.113 a
F. test	*	**	*	**	**	**	NS	**
Nitrogen level (N): kg N/fad.cut								
15	5.37 c	7.03 b	3.17 c	15.56 c	2.240 c	2.405 b	0.907 c	5.552 c
30	5.88 b	8.24 a	4.87 b	18.01 b	2.448 b	2.845 a	1.040 b	6.333 b
45	6.22 a	8.27 a	4.31 a	18.77 a	2.588 a	2.820 a	1.220 a	6.628 a
F. test	**	**	**	**	**	**	**	**
Interaction D x N	NS	NS	NS	NS	NS	**	NS	**

*,** and NS indicates significance at 0.05 and 0.01 levels and not significant, in respective order.
TFSY = Total fresh seasonal yield. TDSY = Total dry seasonal yield.

was done on late May in the second season respectively (28th April 2016 and 20th May 2017). The present results could be strongly supported by the findings of (**Soliman, 2000; Wadi *et al*., 2004; Manjanagouda, 2015**). Also, **Machicek (2018)** who reported that cutting forage pearl millet (*Pennisetum glaucum* (L.) Leeke) at (90 DAS) produced the maximum dry yield compared to cutting at (30 and 45 DAS).

Regarding the influence of N fertilizer levels on fresh yield and TFSY (ton/fad.), as well as, dry yield and TDSY (ton/fad.) during both growing seasons, the results presented in (Table 4) indicated significant to highly significant differences across all the cuts in both growing seasons. It was clear that, the highest values obtained for fresh forage yield and TFSY as well as the dry yield and TDSY (ton/fad.), were obtained under application of the highest applied N fertilizer level (45 kg N/fad./cut.), followed descendangly by 30 and 15 kg N/fad./cut), respectively. However, N level had no significant effect on dry forage yield (ton/fad.) in the 1st cut during first season (Table 4). The present results indicated that, the highest fresh and dry forage yields (ton/fad.) of pearl millet cultivar Shandaweel 1 was increased by the increase of N level up to 45 kg N/fad./cut, followed by 30 and 15 kg N/fad./cut, respectively. So far, the interaction result between the studied factors revealed a significant effect on dry forage yield (ton/fad.) at the 2nd cut in the second season (Table 4-a), and TDSY (ton/fad.) (Table 4-b) in the second season. From the interaction results, the highest dry yield values (3.653, 3.593 ton/fad.) and the highest TDSY values (7.607, 7.500 ton/fad.) were achievable under late cutting by application of either (30 or 45 kg N/fad./cut), respectively. Therefore, the application of 30 kg N/fad./cut for obtaining these traits is recommendable for

Table 4-a. Effect of the interaction between cutting date and nitrogen fertilizer levels on dry forage yield (ton/fad.) of pearl millet at 2nd cut in 2nd season

Cutting date	Nitrogen fertilizer level (Kg N/fad./cut)		
	15	**30**	**45**
	B	A	A
Early	1.870 b	2.037 b	2.047 b
	B	A	A
Late	2.940 a	3.653 a	3.593 a

Table 4-b. Effect of the interaction between cutting date and nitrogen fertilizer levels on total dry seasonal yield (ton/fad.) of pearl millet in 2nd season

Cutting date	Nitrogen fertilizer level (Kg N/fad./cut)		
	15	**30**	**45**
	C	B	A
Early	4.853 b	5.167 b	5.650 b
	B	A	A
Late	6.250 a	7.500 a	7.607 a

farmers use considering both the economic and environmental aspects. Nevertheless, the realized significant increase in forage yield as affected by N application in the current findings could be attributed to the increase occurred in plant height, leaf area per plant and fresh forage weight (g)/plant (Table 3). These results are in harmony with those reported by **Bramhaiah *et al.* (2018)**, **Ibrahim *et al.* (2014), Joshi *et al.* (2018), Kumawat *et al.* (2017), Shahin *et al.* (2013), Sheoran *et al.* (2016), Thakor *et al.* (2018).**

Conclusion

It is concluded from the results of the present study that, all the studied growth characters of pearl millet cultivar Shandaweel 1 gave significantly higher values mostly by cutting at late cutting dates (63 DAS), (42 days after 1st cut) and (35 days after 2nd cut) for the three cuts, respectively. Late cutting (63 DAS) and (42 days after 1st cut and 2nd cut respectively) produced the highest fresh and dry forage yields in addition to their total seasonal yield. It was quite evident that increasing the nitrogen fertilizer level caused significant increase in growth and forage yield attributes. For enriched growth and high yield production, it is concluded that pearl millet cultivar Shandaweel 1 should be best cut at 63 DAS, then after 42 and 35 days interval for next cuts under a three cuts systems, with application of 45 kg N/fad./cut under the particular agro-climatic conditions of Sharkia Governorate in Egypt and similar areas.

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تأثير ميعاد الحش والتسميد النيتروجينى على النمو ومحصول العلف فى الدخن

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أُجريت هذه التجربة بالمزرعة التجريبية لكلية الزراعة، جامعة الزقازيق، محافظة الشرقية، مصر، خلال موسمي الصيف ٢٠١٦ و ٢٠١٧، واستخدم تصميم القطع المنشقة مرة واحدة في ثلاث مكررات، وتكونت عوامل الدراسة من ميعادين للحش (مبكر ومتأخر) حيث تم أخذ الحشة الأولى في الميعاد المبكر بعد ٥٦ يوماً من الزراعة، والحشة الثانية بعد ٣٥ يوماً من الحشة الأولى والحشة الثالثة بعد ٣٥ يوماً من الحشة الثانية، بينما تم أخذ الحشة الأولى في الميعاد المتأخر بعد ٦٣ يوماً من الزراعة والحشة الثانية بعد ٤٢ يوماً من الحشة الأولى والحشة الثالثة بعد ٤٢ يوماً من الحشة الثانية، وثلاث مستويات تسميد نيتروجيني هي (١٥، ٣٠ و٤٥ كجم/ن/الفدان/الحشة)، أوضحت النتائج المتحصل عليها أن ميعاد الحش المتأخر أعطت معنويا أعلى القيم لصفات النمو المدروسة- ارتفاع النبات (٢٣٨,٢ سم)، مساحة أوراق النبات (٤٩٧٠,٢ سم^{٢}) والوزن الغض للنبات (١٦٤ جم/نبات)، وكذلك أعلى وزن غض وجاف لمحصول العلف (١٦,٨٨ و ٣,٥٤ طن/الفدان)، وتم الحصول على أعلى وزن للمحصول الكلى الموسمي الغض والجاف (٣٧,٩٨ و ٧,١١ طن/الفدان) في الميعاد المتأخر للحش في كلا الموسمين، وتبين أن أعلى القيم المعنوية التي تم الحصول عليها لصفات النمو المدروسة ومحصول العلف خلال الموسمين كانت نتيجة زيادة مستويات التسميد النيتروجيني حتى المستوى الأعلى ٤٥ كجم/ن/الفدان/الحشة، يليها المستويات ٣٠ و١٥ كجم/ن/الفدان/الحشة على التوالي، وبينت نتائج تداخل الفعل المعنوي بين عاملي الدراسة بأن أعلى محصول جاف كلى موسمي (٧,٦٧ طن/الفدان) للدخن أمكن الحصول عليه عند ميعاد الحش المتأخر وبإضافة ٤٥ كجم/ن/الفدان/الحشة، وقد خلصت نتائج الدراسة الحالية إلى أن الحش عند ٦٣ يوم بعد الزراعة، ثم بعد ٤٢ و٣٥ يوم للحشات التالية على نظام الثلاث حشات مع تطبيق المستوى ٤٥ كجم/ن/الفدان/الحشة تعتبر الأمثل للنمو الجيد وأفضل محصول علف للدخن صنف شندويل ١ تحت الظروف الزراعية والمناخية لمحافظة الشرقية فى مصر والمناطق المشابهة لها.

المحكمـــــون:

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