FACULTY OF AGRICULTURE

Minia J. of Agric. Res. & Develop.
Vol. (40), No. 2, pp. 277-291, 2020

RESPONSE OF GAZON GRASS PLANTS TO SEED RATES AND NPK FERTILIZATION

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Received: 21 Feb (2021) Accepted: 28 Jan (2021)

ABSTRACT

The present study was carried out under new Minia city conditions, Minia, Egypt during two seasons of 2017/2018 and 2018/2019 to evaluate the response of growth parameters of gazon grass plants to four treatments of seeding rates and NPK fertilizers. All vegetative growth parameters (covering density, plant height, clipping fresh and dry weights of gazon grass plants) showed significant response for seeding rate and NPK fertilization in the two seasons in addition to the photosynthetic pigments (chlorophyll a, b and carotenoids) in second season All vegetative growth parameters except plant height showed gradual increase parallel with increasing seeding rates and NPK fertilization. The highest seeding rate of 60 g/m^2 recorded the highest covering density, clipping fresh and dry weights of gazon grass plants in both seasons. The highest level of NPK fertilizer alone and seeding rate 60 g/m^2 combined with high level of NPK fertilization recorded the highest values of most vegetative growth parameters and all photosynthetic pigments in comparison with the control in the two seasons.

Keywords: gazon, seed rate, NPK, clipping, photosynthetic, chlorophyll, carotenoids

INTRODUCTION

Gazon grass (*Lolium perenne* L.) is a cool season turfgrass commonly planted in green area. It has several benefits such as mitigating the local climate, reducing the air pollution, stabilizing soil, bring happiness and joy to the soul especially around hospitals and educational facilities, the main element of the gardens and represents the aesthetic and attractive destination of the garden (Jena and Mohanty, 2020).

The green area plants require adequate fertilizers due to the continuous clipping processes that remove a large part of their shoots. The nitrogen element is very important in the formation of strong shoots, as it affects the intensity of color, the ability of the plant to resist diseases, its tolerance to heat, cold and drought, and affects the ability of the plant to replace the cut parts (Guo *et al.,* 2009). Phosphorous is included in many vital processes and affects root and plant growth (Tyler *et al.*, 1981). Potassium is considered one of the important nutrients that affect plant growth, and it enters into many vital processes and affects root growth, rhizomes and stems, and affects tolerance of plants to drought, heat and cold, disease resistance and tolerance of walking and passing over it (Snyder and Cisar, 2000).

Kumar and Nikhil (2016) studied the effect of NPK (15:15:15) fertilizers on the vegetative growth characters of vetiver grass (*Vetiveria zizanioides*). The results revealed that fertilization of vetiver grass with NPK resulted in the maximum values of height and weight of grass shoots (17.55 cm and 31.75 g, respectively) compared to control (14.9 cm and 31.75 g). Ihtisham *et al.* (2018) investigated the effects of NPK fertilization on perennial ryegrass (*Lolium perenne*). Height, density, dry and fresh weights of turf significantly increased as a result of N and P fertilization. Total chlorophyll (a+b) substantially increased with N, P, and K, respectively. The optimal combination was 30:24:9 and 30:27:6 g m^{-2}. Sharaf El-Din *et al.* (2018) found significant effects of two different fertilization rates recommended 125:66:22 g m^{-2} and 75% of recommended 93.75 N:49.5 P:16.5 K g m^{-2} on clipping fresh and dry weight and chlorophyll a and b of paspalum plants. During the two seasons, significant increase was observed of clipping dry, fresh weight and chlorophyll a of paspalum. Also, application of 75% of recommended fertilization rate led to a significant increase in clipping fresh, dry weight and chlorophyll a and b of paspalum plants compared to the recommended rate. Yilmaz (2019) reported that the best turf cover was recorded from the application treatment of 30:15:15 g m^{-2} fertilizer rate in comparison with control on turf mixture *Lolium perenne* L., *Festuca rubra rubra* L., *Festuca rubra commutata Gaud* and *Poa pratensis* L. Jena and Mohanty (2020) found that the highest dose of (30 N:15 P:5 K gm m^{-2}) gave the highest values of clipping shoot length, covering density and leaf chlorophyll content compared to control of Bermuda lawn grass.

Using the optimal seeding rates at the seeding time is critical to establish a turf plant. Seeding rates lower than optimum will result in low covering density of turfgrass stand, creating suitable surface for weed invasion. In contrast, excessive high seeding rates will result in establishing turf stand contains a high number of small and immature plants which are not tolerant to environmental stresses as wear from more walking, heat, drought, cold (Minner *et al.* 2008). Therefore, it is important to use the recommended seeding rate. The required quantity of seeds per unit area is different according to the type of flat plant, germination percentage, degree of purity and degree of density required.

Minner *et al.* (2008) found that the effect of seeding rate on turf covering percent was more noticeable for perennial ryegrass than Kentucky bluegrass. Perennial ryegrass grown in early autumn gave more turf cover than broadcasting the same seed amount throughout the playing season. Under the traffic intensity, cover% of perennial ryegrass increased parallel with increased seeding rate to 150 g m^{-2}. Kentucky bluegrass turf cover% was increased from 29 to 65% parallel with increasing seeding rate from 5 to 35 g m^{-2}. Applying seeding rates higher than normal rates during traffic was appropriate to improve turf cover.

The objective of the present study was to evaluate the effects of seeding rates, NPK fertilizers and their combination on growth parameters of gazon grass plant.

MATERIALS AND METHODS

The present study was carried out under new Minia city conditions, Minia, Egypt during two seasons of 2017/2018 and 2018/2019 to estimate the response of growth parameters of gazon grass plant to four seeding rates, four NPK fertilizers and their interactions.

The seeds of gazon grass plant were sown in a sandy soil in December 1st of 2017/2018 and 2018/2019 seasons. Soil samples were obtained from a depth of 30 cm from the used soil surface in this study and some physical and chemical properties of the soil were performed according to the methods described by Jackson (1973) as shown in Table (1).

Table (1). The physical and chemical analyses of the soil used in the study.

Chemical analysis									
pH	EC	Cations (meq/l)			K^+	Anions (meq/l)			
	dS m -1	Ca^{2+}	Mg^{2+}	Na^+	ppm	Cl^-	CO_3^-	HCO_3^-	$SO_4^=$
8.58	75	0.36	0.17	0.23	5	0.36	0.00	0.75	0.12

Physical analysis			
Clay %	Silt %	Sand %	Texture grade
3.16	8.00	88.84	Sandy soil

Seeds of gazon grass broadcasted in each experimental plot 1 m^2. The experiment was regularly irrigated as needed to keep the soil surface moist until complete seedling emergence, then irrigation was applied regularly thereafter. The experiment was including 16 treatments which were arranged in a split-plot in a complete randomized block design with three replications. The four seeding rates (30, 40, 50 and 60 g m^{-2}) allocated in the main plots. The four nitrogen (N), phosphorus (P) and potash (K) NPK fertilizers i.e., without fertilization (control), low level of NPK fertilizers, medium level of NPK fertilizers and high level of NPK fertilizers were randomly allocated in the sub plots.

The high level of NPK fertilizers were 30 g m^{-2} of urea (46.5% N) + 15 g m^{-2} of calcium superphosphate (15.5 % P_2O_5) + 15 g m^{-2} of potassium sulphate (48 % K_2O). So, the high level of NPK fertilizers (60 g NPK m^{-2}) was equal to 30 + 15 + 15 and the medium level of NPK fertilizers (40 g NPK m^{-2}) = 20 + 10 + 10 g m^{-2} and the low level of NPK fertilizers (20 g NPK m^{-2}) = 10 + 5 + 5 g m^{-2}. Plants were daily irrigated until establishment. The fertilization treatments were applied three times, the first one after 1 week of seedling emergence and the second after the first cut and the third one after the second clipping.

Data were recorded on covering density (C.D.) % measured by quadrate frame according to El-Tantawy *et al*. (1993), plant height (P.H.) in cm., fresh weight (F.W.) in g. m^{-2} and dry weight (D.W.) in g. m^{-2} for three clippings at 15 January, 15 February and 15 March of 1st, 2nd and 3rd clippings, respectively in the two seasons. Clapping of the plants was done at 3 cm above soil surface. Chlorophyll a, b and carotenoids in the leaves (mg/g F.W.) were determined according to Nagata and Yamashita (1992).

The collected data were subjected to the statistical analysis and means were compared using the L.S.D. at 5% as described by Gomez and Gomez (1984). The statistical analysis was done using the computer program MSTATE-C software version 4.

RESULTS AND DISCUSSION

I- Vegetative growth parameters:

All studied vegetative growth parameters; covering density, plant height, clippings fresh and dry weight of gazon grass plants showed significant response for seeding rate and NPK fertilization and their interaction of the three clippings in the two seasons as indicated from LSD values (Tables 2, 3, 4 and 5).

Covering density gradually increase parallel with increasing seed rate. The highest seeding rate (60 g m^{-2}) recorded the highest covering density by 49.58, 54.45 and 58.33% in first season and 50.34, 65.83 and 58.59% in the second season of 1st, 2nd and 3rd clippings, respectively in comparison with the other seeding rates and the control (Table, 2). Minner *et al*. (2008) evaluated the ability of the overseeded grass species to establish Kentucky bluegrass (*Poa pratensis* L.) and perennial ryegrass (*Lolium perenne* L.). The effect of seeding rate on turf covering percent was more noticeable for perennial ryegrass. Under the traffic intensity, cover% of perennial ryegrass and Kentucky bluegrass increased parallel with increased seeding rate. Hanks *et al.* (2006) estimated the recommended seeding rates for turf three populations of wheatgrasses (*Agropyron cristatum* L.), *Elymus lanceolatus* and tall fescue (*Festuca arundinacea* Schreb). They found that the highest covering rates were obtained from higher seeding rates compared lower seeding rates.

The highest level of NPK fertilizer recorded the highest covering density of gazon grass in all clipping by (53.42 and 55.17%) of 1st clipping, (58.34 and 58.92%) of 2nd clipping and (76.33 and 76.33%) of 3rd clipping of first and second seasons, respectively compared to the other two levels and control. While the treatment that contained the lowest NPK fertilizers gave low covering density but still higher than the control (Table 2). These results refer to the positive effect of increase seeding rate on covering density of gazon grass plants. Yilmaz (2019) revealed that the best turf covering% was recorded with 30:15:15 g m^{-2} fertilizer rate in comparison with control. Akdeniz and Hosaflioglu (2016) found that all eight levels of nitrogen applications positively affected cover density of perennial ryegrass. They showed significant response for the doses of nitrogen fertilizer on cover density.

The interaction between the highest seeding rate 60 g m^{-2} and the highes level of NPK fertilizers gave the highest covering density 66.00, 72.00 and 76.33% in first season and 67.33, 71.00 and 77.67% in second season of 1st, 2nd and 3rd clippings, respectively (Table, 2).

In 1st season, the two treatments 60 g m^{-2} alone and 30 g m^{-2} + high level of NPK interaction recorded covering density by 39.33 and 38.67% of 1st clipping, 43.33 and 42.67% of 2nd clipping and 46.67 and 45.67% of 3rd clipping without significant difference between the two treatments. Meaning that increase NPK fertilizer to high level could compensate for the reduction in seeding rate 30 g m^{-2} (Table, 2). Also, similar trend was found, but with the two treatments 40 g m^{-2} alone and 30 g m^{-2} + medium level of NPK interaction without significant difference in all clippings.

In 2nd season, the interaction of seeding rate 30 g m^{-2} with each of medium level and high level of NPK recorded higher covering density without significant difference (40.33 and 40.67%), (44.00 and 45.00%) and (48.33 and 49.33%) of 1st, 2nd and 3rd clippings, respectively. Indicating, the ability to save 33.33% from NPK fertilizers and gave the same result of covering density of high level of NPK. Toler *et al.* (2007) observed that the rate of N fertilization with the two highest rates 97.6 and 195.2 kg ha^{-1} resulted in the optimal coverage for turfgrass of 94% to 98%. They concluded that the acceptable coverage of turfgrass centipede grass could be achieved with 97.6 kg ha^{-1} N rate.

Plant height of gazon grass plants was negatively correlated with increasing seeding rate. Where, the lowest seed rate 30 g m^{-2} gave the highest plant height by 15.09, 15.13 and 14.88 cm in 1st season and 16.54, 16.22 and 15.93 cm in 2nd season of 1st, 2nd and 3rd clippings, respectively and vice versa (Table, 3). This may be attributed to the increase in plant density due to the increase in seed rate 60 g m^{-2}, indicating the negative effect of increasing seeding rate on plant height. Simic *et al.* (2009) found that ryegrass height was negatively affected by plant stand density.

Application of the highest level of NPK fertilizers recorded the tallest gazon grass plants in all clippings of both seasons. While the control treatment gave the shortest gazon grass plant (Table 3). These results indicated the positive effect of increase NPK fertilizers on plant height of gazon grass plants. Ihtisham *et al.* (2018) found that ryegrass height was significantly increased as a result of N and P fertilization. The optimal combination was 30:24:9 and 30:27:6 g m^{-2}. Akdeniz and Hosaflioglu (2016) reported that all nitrogen applications positively affected plant height of perennial ryegrass.

The tallest gazon grass plants were recorded from the application (the interaction) of 30 gm/m^2 with high level of NPK fertilizers in all clippings of two seasons (Table, 3). Reflecting the relative importance for the role of high ratio of NPK fertilizers to compensate for low seeding rate to obtain the highest plant height of gazon grass. The two interactions (30 gm/m^2 seeding rate and the low level of NPK) and (60 gm/m^2 seed rate and the medium level of NPK) were recorded medium plant height without significant difference of 1st clipping in first season and both first and third clippings in second season. Indicating the ability to save 50% from seed rate and NPK fertilizers quantity to obtain medium plant height of gazon grass (Table, 3). Generally, in all clippings the control was recorded the shortest gazon grass plants compared to all interactions.

The gradually increase in clipping fresh weight was found parallel with increasing seeding rate and NPK fertilizers. The highest fresh weight was recorded from application of the highest seed rate (60 g m^{-2}) and the the high level of NPK fertilizers compared to the two other treatments and control in all clippings of the two seasons (Table, 4). Reflecting the relative importance of increasing ratio of NPK fertilizers in increasing clipping fresh weight of gazon grass plants. Akdeniz and Hosaflioglu (2016) showed a significant response for the doses of nitrogen fertilizer on green grass yield. They concluded that the two nitrogen levels of 40 and 50 kg ha^{-1} were more suitable for ryegrass landscape.

In all clipping of the two seasons, 60 g seeds m^{-2} + the high level of NPK fertilizers interaction recorded the heaviest fresh weight compared to the other treatments and control (Table, 4). In the last clipping (No. 3), the two interactions of the high level of NPK fertilizers with each of 40 and 50 g m^{-2} seed rates recorded higher fresh weight by 1450 and 1455 gm, respectively without significant difference between them in the first season (Table, 4), indicating that high level of NPK fertilizers save 10 g m^{-2} only of gazon grass seed. The control treatment recorded the lightest fresh weight of gazon grass plants in all clippings. McMahon and Hunter (2010) showed that dry and fresh weight yields of turf *Agrostis stolonifera* were affected by the level of fertilizer. Alderman *et al.* (2011) observed that increasing N rate from 0 to 135 kg ha^{-1} increased total plant mass. Pease *et al.* (2011) found that clipping fresh weight was increased parallel with increasing N rate.

Clipping dry weight showed the same trend of fresh weight in all clippings of both seasons, where dry weight showed gradual increase parallel with increasing seeding rates and levels of NPK fertilizers. The treatment that contained high seed rate 60 g m^{-2} gave the heaviest dry weight by 342.88, 352.47 and 371.15 g in first season and 339.93, 368.03

and 381.77 g in second season of clipping 1, 2 and 3, respectively compared to other three seeding rates. The lowest seed rate 30 g m^{-2} recorded the lightest dry weight of all clippings (Table, 5). Simic *et al.* (2009) found that shoot dry weight g m^{-2} of ryegrass was considerably less affected by the four seeding rates. Abundant shoot dry weight was obtained with some seeding rates.

The highest overall dry weight was obtained when gazon grass plants were supplied with the highest NPK fertilizers by 478.86, 494.93 and 511.93 g m^{-2} in 1st season and 482.12, 496.83 and 510.97 g m^{-2} in 2nd season of clipping one, two and three, respectively. Turk and Sozoren (2016) found that increasing N fertilization doses increased dry matter of perennial ryegrass.

Dry weight showed the same trend of fresh weight for gazon grass plants in all clippings of the two seasons. Where, the highest clipping dry weight was obtained from application of high level of the two studied factors (60 g m^{-2} + the high level of NPK fertilizers) compared to other treatments and the control (Table, 5).

Insignificant differences were found for the interaction of the high level of NPK fertilizers with each of 50 and 60 g m^{-2} by 495.23 and 492.97 g, respectively in first clipping (Table, 5) and the interaction of the high level of NPK fertilizers with each of 40 and 50 g m^{-2} by 5.07.02 and 509.23 gm, respectively in third clipping of 1st season. This indicating that the high level of NPK fertilizers save only 10 gm gazon seed of the two interactions to achieve high dry weight. Kuo (2015) indicated that fast-release and slow-release fertilizers recorded plant dry weight of bermuda grass by 8.14 and 4.00 g in comparison with control 3.62 g and shoot dry weight by 2.30 and 2.20 g compared to 1.88 g of control treatment for fast-release and slow-release fertilizer, respectively.

II- Photosynthetic pigments

Seeding rate, NPK fertilizers and their interaction showed significant effect on chlorophyll a, b and carotenoids according to LSD values (Table, 6). All photosynthetic pigments were negatively correlated with increasing seeding rate. Where, the highest values of chlorophyll a, b and carotenoids were recorded from the lowest seeding rate 30 g m^{-2} by 2.40, 1.04 and 1.11 mg/g f.w., respectively. While, the highest seeding rate 60 g m^{-2} recorded the lowest values of the three pigments (Table, 6). This may be attributed to high competition among plants on environmental growth factors in high plant density of seed rate 60 g m^{-2}.

On the other hand, linear increase in chlorophyll a, b and carotenoids was observed with the increase of NPK fertilizer level. Where, the highest level of NPK fertilizers recorded the highest values by 2.79, 1.02 and 1.34 mg/g f.w. of chlorophyll a, b and carotenoids, respectively compared to the other levels and the control (Table, 6).

Table (2). Effect of seeding rate (A), NPK fertilizer (B) on covering density (%) of three clippings of *Lolium perenne* L. during the 2017/2018 and 2018/2019 seasons.

Treatments	**First season 2017/2018**					**Second season 2018/2019**				
	Control	Low NPK	Medium NPK	High NPK	Mean (A)	Control	Low NPK	Medium NPK	High NPK	Mean (A)
	First clipping									
30 g m^{-2}	26.00l	29.33	33.00j	38.67gh	31.75d	25.33l	32.00k	40.33g	40.67g	34.58d
40 g m^{-2}	33.00j	30.67k	36.67i	51.67c	38.00c	31.00k	36.67i	42.00f	50.33d	40.00c
50 g m^{-2}	37.33hi	37.67hi	42.67f	57.33b	43.75b	34.00j	38.67h	44.00e	62.33b	44.75b
60 g m^{-2}	39.33g	45.33e	47.67d	66.00a	49.58a	38.67h	43.67e	51.67c	67.33a	50.34a
Mean (B)	33.92d	35.75c	40.00b	53.42a	40.77	32.25d	37.75c	44.50b	55.17a	42.42
L.S.D.	A	B	A.B			A	B	A.B		
5%	0.66	0.69	1.39			0.62	0.61	1.22		
	Second clipping									
30 g m^{-2}	28.33m	32.00l	36.67j	42.67gh	34.92d	27.00l	35.00j	44.00g	45.00fg	37.75d
40 g m^{-2}	36.00j	34.00k	40.67i	56.67c	41.84c	32.00k	39.67i	45.67f	52.00d	42.34c
50 g m^{-2}	40.33i	41.33hi	46.67f	62.00b	47.58b	38.33i	44.00g	48.67e	67.67b	49.67b
60 g m^{-2}	43.33g	49.67e	52.67d	72.00a	54.42a	41.33h	48.33e	54.67c	71.00a	53.83a
Mean (B)	37.00d	39.25c	44.17b	58.34a	44.69	34.67d	41.75c	48.25b	58.92a	45.90
L.S.D.	A	B	A.B			A	B	A.B		
5%	0.79	0.86	1.73			1.48	0.75	1.51		
	Third clipping									
30 g m^{-2}	31.00k	34.33j	39.67h	45.67fg	37.67d	29.67n	37.67l	48.33gh	49.33g	41.25d
40 g m^{-2}	39.00hi	36.67ij	44.00g	61.00c	45.17c	35.00m	42.00j	50.67f	59.00c	46.67c
50 g m^{-2}	43.33g	45.00fg	50.67e	66.33b	51.33b	40.67k	47.67h	54.00d	71.33b	53.42b
60 g m^{-2}	46.67f	53.00e	57.33d	76.33a	58.33a	44.67i	52.00e	60.00c	77.67a	58.59a
Mean (B)	40.00d	42.25c	47.92b	76.33a	48.13	37.50d	44.83c	53.25b	76.33a	49.98
L.S.D.	A	B	A.B			A	B	A.B		
5%	1.41	1.29	2.58			0.7	0.51	1.03		

a-k Means in the same column (within) or under the same trait followed by different letters are significantly different (P <0.05).

Table (3). Effect of seeding rate (A), NPK fertilizer (B) on plant height (cm) of three clippings of *Lolium perenne* L. during the 2017/2018 and 2018/2019 seasons.

Treatments	**First season 2017/2018**					**Second season 2018/2019**				
	Control	Low NPK	Medium NPK	High NPK	Mean (A)	Control	Low NPK	Medium NPK	High NPK	Mean (A)
	First clipping									
30 g m^{-2}	5.67g	11.67de	15.67b	27.33a	15.09a	5.67i	13.20f	18.30d	29.00a	16.54a
40 g m^{-2}	5.00g	10.83ef	15.17bc	27.33a	14.58ab	5.17i	12.00g	17.20e	28.00ab	15.59b
50 g m^{-2}	4.67g	9.83ef	14.33bc	27.67a	14.1b	5.17i	11.20g	16.20e	27.67b	15.06c
60 g m^{-2}	4.33g	9.00f	13.33cd	28.00a	13.67b	5.17i	8.00h	14.00f	26.00c	13.29d
Mean (B)	4.92d	10.33c	14.63b	27.58a	14.36	5.30d	11.10c	16.43b	27.67a	15.12
L.S.D.	A	B	A.B			A	B	A.B		
5%	0.92	1.095	2.19			0.7	0.51	1.01		
	Second clipping									
30 g m^{-2}	4.67i	11.00f	15.83c	29.00a	15.13a	5.33k	13.00g	18.20d	28.33a	16.22a
40 g m^{-2}	4.33i	10.00fg	15.00cd	28.33ab	14.42b	5.17k	12.00h	18.53d	26.67b	15.59b
50 g m^{-2}	4.17i	9.00gh	14.00de	28.00ab	13.79c	4.83kl	11.00i	16.30e	25.67c	14.45c
60 g m^{-2}	4.00i	8.00h	13.00e	27.00b	13.00d	4.17l	8.30j	14.30f	25.33c	13.03d
Mean (B)	4.29d	9.50c	14.46b	28.08a	14.08	4.88d	11.06c	16.83b	26.50a	14.82
L.S.D.	A	B	A.B			A	B	A.B		
5%	0.24	0.81	1.62			0.37	0.38	0.75		
	Third clipping									
30 g m^{-2}	4.17j	10.00g	16.33d	29.00a	14.88a	4.20j	13.20f	19.00d	27.33a	15.93a
40 g m^{-2}	4.17j	9.00gh	15.33de	28.00ab	14.13b	4.50j	12.30g	18.50d	26.33b	15.41b
50 g m^{-2}	4.17j	8.00j	14.33ef	27.00bc	13.38c	4.20j	11.10h	16.30e	25.33c	14.23c
60 g m^{-2}	4.00j	7.00i	13.33f	26.00g	12.58d	4.17j	8.10i	14.00f	24.67c	12.74d
Mean (B)	4.13d	8.50c	14.83b	27.50a	13.74	4.20d	11.18c	16.95b	25.92a	14.58
L.S.D.	A	B	A.B			A	B	A.B		
5%	0.14	0.88	1.77			0.22	0.41	0.83		

a-k Means in the same column (within) or under the same trait followed by different letters are significantly different ($P < 0.05$).

Table (4). Effect of seeding rate (A), NPK fertilizer (B) on fresh weight (g) of three clippings of *Lolium perenne* L. during the 2017/2018 and 2018/2019 seasons.

Treatments	**First season 2017/2018**					**Second season 2018/2019**				
	Control	Low NPK	Medium NPK	High NPK	Mean (A)	Control	Low NPK	Medium NPK	High NPK	Mean (A)
	First clipping									
30 g m^{-2}	155.00f	750.00l	1068.67h	1295.00d	817.17d	145.00p	755.00l	1105.00h	1305.00d	827.50d
40 g m^{-2}	195.00o	800.00k	1113.33g	1354.67c	865.75c	195.00o	795.00k	1150.00g	1365.00c	876.25c
50 g m^{-2}	240.00n	840.00j	1165.00f	1400.00b	911.25b	245.00n	845.00j	1195.00f	1395.00b	920.00b
60 g m^{-2}	385.00m	915.00i	1205.00e	1405.00a	977.50a	305.00m	905.00i	1230.00e	1445.00a	971.25a
Mean (A)	243.75d	826.25c	1138.00b	1363.67a	892.20	222.50d	825.00c	1170.00b	1377.50a	898.75
L.S.D.	A	B	A.B			A	B	A.B		
5%	3.56	2.44	4.87			2.22	1.93	3.86		
	Second clipping									
30 g m^{-2}	205.00p	790.00l	1107.00h	1325.00d	856.75d	195.00p	845.00l	1145.00h	1351.67d	884.17d
40 g m^{-2}	255.00o	835.00k	1155.00g	1395.00c	910.00c	235.00o	885.00k	1195.00g	1395.00c	927.50c
50 g m^{-2}	290.00n	885.00j	1217.00f	1435.00b	956.75b	281.67n	925.00j	1225.00f	1435.00b	966.67b
60 g m^{-2}	340.00m	955.00i	1245.00e	1495.00a	1008.75a	345.00m	1105.00i	1255.00e	1495.00a	1050.00a
Mean (A)	272.50d	866.25c	1181.00b	1412.50a	933.06	264.17d	940.00c	1205.00b	1419.17a	957.08
L.S.D.	A	B	A.B			A	B	A.B		
5%	3.35	3.58	7.15			3.68	2.26	4.52		
	Third clipping									
30 g m^{-2}	256.67o	835.00k	1145.00g	1390.00c	906.67d	223.33p	895.00l	1185.00h	1395.00d	924.58d
40 g m^{-2}	305.00n	890.00j	1205.00f	1450.00b	962.50c	278.33o	935.00k	1205.00g	1435.00c	963.33c
50 g m^{-2}	335.00m	910.00i	1255.00e	1455.00b	988.75b	320.00n	965.00j	1265.00f	1475.00b	1006.25b
60 g m^{-2}	385.00l	1005.00h	1291.67d	1555.00a	1059.17a	388.33m	1145.00i	1295.00e	1535.00a	1090.83a
Mean (A)	320.42d	910.00c	1224.17b	1462.50a	979.27	302.45d	985.00c	1237.50b	1460.00a	996.25
L.S.D.	A	B	A.B			A	B	A.B		
5%	9.25	7.85	15.7			2.16	3.34	6.68		

a-k Means in the same column (within) or under the same trait followed by different letters are significantly different (P <0.05).

Table 5. Effect of seeding rate (A), NPK fertilizer (B) on dry weight (g m^{-2}) of three clippings of *Lolium perenne* L. during the 2017/2018 and 2018/2019 seasons.

Treatments	First season 2017/2018					Second season 2018/2019				
	First clipping									
	Control	Low NPK	Medium NPK	High NPK	Mean (A)	Control	Low NPK	Medium NPK	High NPK	Mean (A)
30 g m^{-2}	54.57o	262.50k	373.90g	453.13c	286.03d	50.60p	264.27l	386.63h	456.77d	289.57d
40 g m^{-2}	68.23n	280.00j	389.63f	474.10b	302.99c	68.23o	278.23k	402.47g	477.73c	306.66c
50 g m^{-2}	84.00m	294.00i	407.73e	495.23a	320.24b	85.73n	295.73j	418.23f	488.20b	321.97b
60 g m^{-2}	136.60l	320.23h	421.73d	492.97a	342.88a	106.73m	316.73i	430.50e	505.77a	339.93a
Mean (A)	85.85d	289.18c	398.25b	478.86a	313.03	77.82d	288.74c	409.46b	482.12a	314.53
L.S.D.	A	B	A.B			A	B	A.B		
5%	2.57	1.96	3.92			0.73	0.68	1.37		
	Second clipping									
30 g m^{-2}	71.73p	276.47l	387.43h	463.73d	299.84d	68.23p	295.70l	400.73h	473.80d	309.62d
40 g m^{-2}	89.23o	292.30k	404.10g	488.20c	318.46c	82.23o	309.73k	417.90g	488.20c	324.52c
50 g m^{-2}	101.50n	309.57j	425.23f	502.27b	334.64b	97.43n	323.77j	428.70f	502.20b	338.03b
60 g m^{-2}	116.73m	334.13i	435.73e	523.27a	352.47a	123.07m	386.70i	439.23e	523.10a	368.03a
Mean (A)	94.80d	303.12c	413.12b	494.37a	326.35	92.74d	328.98c	421.64b	496.83a	335.05
L.S.D.	A	B	A.B			A	B	A.B		
5%	1.33	1.16	2.32			1.66	1.37	2.74		
	Third clipping									
30 g m^{-2}	89.73o	292.23k	400.63g	486.37c	317.24d	78.27p	313.43l	414.73h	488.20d	323.66d
40 g m^{-2}	106.77n	311.23j	421.73f	507.20b	336.732c	97.40o	327.27k	421.70g	502.23c	337.15c
50 g m^{-2}	117.23m	318.43i	439.23e	509.23b	346.03b	111.90n	337.23j	442.73f	516.23b	352.02b
60 g m^{-2}	134.73l	352.90h	452.03d	544.93a	371.15a	135.93m	400.73i	453.23e	537.20a	381.77a
Mean (A)	112.12d	318.70c	428.41b	511.93a	342.79	105.88d	344.67c	433.10b	510.97a	348.65
L.S.D.	A	B	A.B			A	B	A.B		
5%	3.46	2.79	5.57			0.66	1.1	2.2		

a-k Means in the same column (within) or under the same trait followed by different letters are significantly different (P <0.05).

The interaction between the lowest seeding rate 30 g m^{-2} and the highest level of NPK fertilizers recorded the highest values of chlorophyll a, b and carotenoids by 2.89, 1.18 and 1.34 mg/g f.w., respectively, indicating the importance role of NPK fertilizers increase to compensate for the reduction in seed rate to achieve the best values. Insignificant differences of chlorophyll a were found between the interactions (high level of NPK + 40 g m^{-2} and high level of NPK + 50 g m^{-2}), (the medium level of NPK + 30 g m^{-2} and the high level of NPK + 60 g m^{-2}), (the high level of NPK + 50 g m^{-2} and the high level of NPK + 60 g m^{-2}) and (the medium level of NPK + 50 g m^{-2} and the medium level of NPK + 60 g m^{-2}).

Insignificant differences of chlorophyll b were found between the interactions (the low level of NPK + 30 g m^{-2}) and (the high level of NPK + 60 g m^{-2}) by 0.98 and 0.99 mg/g f.w., indicating ability save half quantity of gazon seeds 30 gm and two third quantity of NPK fertilizers (the medium level) and obtain the same value of chlorophyll b (Table, 6). El Maadawy *et al.* (2006) found that chlorophyll a, b and carotenoid contents were increased with the application of NPK. Pease *et al.* (2011) found that chlorophyll a and b of velvet bentgrass (*Agrostis canina* L.) increased parallel with increased N rate. Ihtisham *et al.* (2018) showed substantially increase for total chlorophyll (a+b) by N and P fertilization and with N, P, and K of ryegrass. Sharaf El-Din *et al.* (2018) found significant effects of two NPK fertilization rates on chlorophyll a and b of paspalum plants. Jena and Mohanty (2020) concluded that the highest dose of (30 N: 15 P: 5 K g m^{-2}) gave the highest values of leaf chlorophyll content compared to control of bermuda lawn grass.

Table (6). Effect of the four seed rates, NPK fertilizers and interaction on chlorophyll a, b and carotenoids (mg/g f.w.) clipping in second season 2018/2019

Seed rate	**Chlorophyll a**				
	Control	Low NPK	Medium NPK	High NPK	Mean (A)
30 g m^{-2}	1.86ij	2.20g	2.63d	2.89a	2.40a
40 g m^{-2}	1.80jk	2.02h	2.54e	2.80b	2.29b
50 g m^{-2}	1.76kl	1.92i	2.44f	2.77bc	2.23c
60 g m^{-2}	1.70l	1.80jk	2.40f	2.70cd	2.15d
Mean (A)	1.78d	1.99c	2.50b	2.79a	2.26
L.S.D.	A	B	A.B		
5%	0.01	0.038	0.075		
			Chlorophyll b		
30 g m^{-2}	0.91d	0.98c	1.08b	1.18a	1.04a
40 g m^{-2}	0.89d	0.90d	0.90d	1.00c	0.92b
50 g m^{-2}	0.80e	0.90d	0.97c	0.91d	0.90bc
60 g m^{-2}	0.73f	0.89d	0.90d	0.99c	0.88c
Mean (A)	0.83d	0.92c	0.96b	1.02a	0.93
L.S.D.	A	B	A.B		
5%	0.032	0.027	0.053		
			Carotenoids		
30 g m^{-2}	0.99d	1.00d	1.10c	1.34a	1.11a
40 g m^{-2}	0.90ef	1.00d	1.09c	1.24b	1.06b
50 g m^{-2}	0.88fg	0.96d	1.08c	1.12c	1.01c
60 g m^{-2}	0.83g	0.95de	1.09c	1.10c	0.99d
Mean (A)	0.90d	0.98c	1.09b	1.20a	1.04
L.S.D.	A	B	A.B		
5%	0.01	0.027	0.053		

a-k Means in the same column (within) or under the same trait followed by different letters are significantly different ($P < 0.05$).

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استجابة نباتات الجازون لمعدلات التقاوى والتسميد المعدنى

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نفذت هذه الدراسة تحت ظروف مدينة المنيا الجديدة – محافظة المنيا – مصر خلال موسمين متتاليين 2018/2017 و2019/2018 لتقييم استجابة مقاييس النمو لنباتات الجازون لأربعة معاملات من معدلات التقاوى واربع معاملات من التسميد المعدنى NPK، أظهرت كل صفات النمو الخضرية (كثافة التغطية، ارتفاع النبات، الوزن الطازج ، الوزن الجاف للحشات) فى كلا الموسمين بالاضافة إلى صبغات التمثيل الضوئى (كلوروفيل أ ، ب ، الكاروتينات) فى الموسم الثانى استجابة معنوية لمعدلات التقاوى والتسميد المعدنى NPK والتفاعل بينهم. كما أظهرت كل مقاييس النمو الخضرى باستثناء ارتفاع النبات زيادة تدريجية بالتوازى مع زيادة معدلات التقاوى والتسميد المعدنى NPK، سجل أعلى معدل تقاوي 60 جم/م^2 أعلى قيم لكل من كثافة التغطية والوزن الطازج والجاف للحشة لنبات الجازون فى كلا الموسمين. كما سجل كل من أعلى مستوى تسميد معدنى بمفردة والتفاعل بين أعلى معدل تقاوي 60جم/م^2 مع أعلى مستوى من التسميد معدنى أعلى قيم لمعظم صفات النمو الخضري وكل صبغات التمثيل الضوئى بالمقارنة مع باقى التفاعلات والكنترول فى كلا الموسمين.

توصى الدراسة بتطبيق أعلى مستوى تسميد معدنى NPK بمفردة أو مجتمعا مع معدل تقاوي 60جم/م^2 لتحقيق أعلى قيم لمعظم صفات النمو الخضري وكل صبغات التمثيل الضوئى لنباتات الجازون