Journal of Plant Production

Journal homepage & Available online at: www.jpp.journals.ekb.eg

Influence of Planting Methods and Seeding Rates on Productivity of Egyptian Clover Forage and some Water Relations

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ABSTRACT

The current experiment was carried out in a clay soil Sids Agricultural Research Station, Beni-Suief Governorate, Egypt, during two successive seasons of (2017/2018 and 2018/2019). This investigation aimed to study the influence of planting methods and seeding rates on productivity of Egyptian clover forage and some water relations. The studied treatments were : four planting methods (flat, ridges, raised beds and ridges without tillage) as well as three seeding rates, 15, 20 and 25 kg seeds/fed,. The results could be summarized as follows:- The treatment of flat or ridges method with 20 kg/fed seeding rate gave the highest values of plant height, leaves/stem ratio, fresh and dry forage yield as well as water use efficiency and water productivity.- The highest values of plant height, leaves/stem ratio as well as fresh and dry forage yields were obtained under flat or ridges planting method, while the highest values of these parameters were obtained under 20 kg/fed seeding rates.- Applied and seasonal consumptive use water were reduced under raised bed method followed by ridges(without tillage), while increasing seeding rates up to 25 kg/fed was significantly increased.- The raised bed method exhibited the highest values of water use efficiency and water productivity as fresh or dry basis. Also, the highest values of these water incidences were obtained under 20 kg/fed seeding rate.- The treatment of raised bed method with 15 or 20 kg/fed seeding rate recorded the lowest applied and seasonal consumptive water, consequently highest amount of saving water.

Keywords: Egyptian clover, planting method, seeding rates, water relations

INTERODUCTION

Egyptian clover (*Trifolium alexandrinum L.*) is the most annual forage crop over the world, especially Mediterranean Sea conditions. In Egypt, the cultivated area was about 1.5 million feddans in 2017/2018 season (Ministry of Agriculture, Economic publication, Bulletin of the Agriculture Statistics. (2018). Egyptian clover has high rate of growth, greatest quality forage and its bloating potential is very low. In winter, it considers the most important crop for feeding life stock during about 6 months in Egypt. El-Nahrawy (2005) mentioned that Egyptian clover has high nutritive value because of its high protein content. Also, it is enhanced physical and chemical soil properties, where it has highest nitrogen fixation potentiality. Both sowing methods and seeding rate are factors as affecting of legumes and non-legumes production Anees. *et al.*, (2020).

Shihata (1982) reported that fresh and dry forage yield of berseem were affected similarly by different sowing methods. Also sown berseem in rows of 40 cm apart produced the highest forage yield of each cut as well as total fresh yield compared with other methods.

The wide- spaced furrow as in case of bed planting method water losses by evapotranspiration minimize water requirements, this may be due to the applying water directly to root zone, while dry soil surface still relatively dry (Stone *et al.*, 1982). The maximizing of the effective of rational uses of limited water; need to adapt the irrigation technologies and irrigation scheduling. For these purposes, it is necessary to develop the optimal crops water requirement as well as its good use of allocated water (Fouad and Abouneinm (2012). In this connection, Ghani *et al.* (2010) stated that narrow beds (65 cm), medium beds (130 cm) and wide beds (180 cm) saved about 3-7, 16-17 and 18-22% water compared with flat basin one. However, Fahong *et al.* (2011) found that bed planting resulted increasing of wheat yield by about 6.6 to 12 % over the traditional basin practice. Abdul Majeed *et al.* (2015) and ICARDA (2016) recommended that using raised bed comparing with traditional flat basing owing to it has many advantages, such as a good irrigation control and drainage decreasing weed growing, facilitate fertilizers application and caused a good plant stand and tillering, consequently increased crop yield but reducing applied water.

Seeding rates is an important agronomic process which affect the microclimate of the field, hence crop productivity. In general, the seeding rates for Egyptian clover ranged between 15 to 30 kg/fed, depending on time and method of planting (Salem *et al.*, 2019). Pea and Bin (2001) found that increasing seeding rate of Egyptian clover up to 25 kg/fed led to highest values of crude protein as well as fiber and ash (%) in plant. Recently, increasing seeding rate up to 30 kg /fed of Egyptian clover exhibited the highest value of plant height and leaves/stem ratio in addition to forage production. In Egypt, Kandil *et al.* (2004) indicated that the highest forage yield of clover plant was recorded under seeding rate of 30 kg/fed. However, Oushy (2008)

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DOI: 10.21608/jpp.2022.141783.1121

reported that 20-25 kg/fed is recommended as seeding rate for maximize green forge and seed production. Seyyed *et al.* (2012) reported that seeding density improve plant stand as well as quality and quantity of clover plant. Salem *et al.*, (2019) showed that 30 kg /fed seeding rate of Egyptian clover exhibited the highest values of clover plant height, leaves/stem ratio number of stem, as well fresh and dry forage yield. The maximizing of the effective of rational for good forage production, it is important to apply appropriate planting method as well as adequate seeding rate.

The objective of this study to investigate the effect of planting methods and seeding rates on forage yield production of Egyptian clover as well as some water relations.

MATERIALS AND METHODS

The present research trial was conducted in 2017/2018 and 2018/2019 winter seasons at the Experimental Farm of Sids Agricultural Research Station, Beni-Suief Governorate (Middle Egypt, Lat. 29º 04' N, Long. 31º 06' E and 30.40 m above the mean sea level) to investigate the effect of four planting method and seeding rates on productivity of Egyptian clover forage as well as some water relations. The soil moisture constants and some physical properties were determined according to Klute (1986) as well as some chemical properties of the experimental soil site according to Ryan *et al.* (1996) listed in Tables 1 and 2.

Table 1. Some soil water constants for the experimental site (2017/2018 and 2018/2019 seasons).

Season	Soil depth (cm)	Field Capacity (%)	Wilting Point (%)	Bulk density (g cm^{-3})	Available Water (%)
2017/2018	00 – 15	45.08	21.58	1.131	23.50
	15 – 30	37.95	18.04	1.244	19.91
	30 – 45	35.95	17.32	1.285	18.63
	45 – 60	33.14	16.04	1.328	17.10
Mean		38.03	18.25	1.247	19.79
2018/2019	00 – 15	46.56	22.17	1.170	24.39
	15 – 30	37.09	17.66	1.299	19.43
	30 – 45	35.55	16.92	1.357	18.63
	45 – 60	33.19	15.80	1.379	17.39
Mean		38.10	18.14	1.301	19.96

Table 2 . Some soil and chemical properties of the experimental site

Season	Particle size distribution			Textural class	Chemical properties					
	Clay %	Silt %	Sand %		OM. %	E.C. (dS/m at 25°C)	Available (ppm) N	P	K	pH
2017/2018	49.90	33.75	16.35	Clay	2.25	0.65	22.05	15.9	208.5	7.8
2018/2019	50.35	32.32	17.33		2.10	0.70	22.52	16.2	210.8	7.9

The experiment was laid out in strip plot design with four replicates. The four planting method were arranged in the lengthwise strips and three seeding rates were arranged in the crosswise strips as following.

1- Lengthwise strips (Planting methods):

P_1 = Flat sowing (traditional farmer practice)

P_2 = Ridges sowing (60 cm)

P_3 = Raised beds sowing (120 cm)

P_4 = Ridges sowing without tillage 60 cm.

2- Crosswise strips (Seeding rates):

S_1 = 15 kg seeds/fed. S_2 = 20 kg seeds/fed. S_3 = 25 kg seeds/fed.

The experimental plot area was 42 m^2 (1/100 feddan). Seeds of berseem variety (Giza 6) were sown on 25th October and 5th November in the first and second years, respectively.

The preceding crop was cowpea in the two seasons. Calcium phosphate (15.5 % P_2O_5) was added at the rate of 200 kg fed^{-1}, during soil preparation and before the first irrigation 15 kg N fed^{-1} (33.5 % N) as an initial dose were carried out normally for all plots. Five cuts were taken in both seasons.

Investigated parameters:

1- Fresh forage yield, 14 m^2 for each plot were hand clipped and weighed in kg plot^{-1} then adjusted to ton fed^{-1}.

2- Dry forage yield (ton fed^{-1}) subsamples of 100 g were dried at 105 C̊ until constant weight to determine dry matter percentage was estimated. The dry forage yield ton fed^{-1} was calculated by multiplying fresh forage weight ton fed^{-1} with dry matter percentage (DM %).

3- Plant height (cm): It was measured from ground to the top of the plant (calculated as average of 10 randomly taken plants).

4- Leaves / stem ratio: by dividing the fresh ^{dns} weight of leaves on fresh ^{dns} weight of stem.

Statistical analysis:

The data of each cut and total yield in every season were statistically analyzed according to Snedecor and Cochran (1980).

The difference between treatments means were compared by least significant differences test at probability level of 5% Gomes and Gomes (1984).

Amount of irrigation water applied:

The amount of water applied for each irrigation was determined based on of raising the soil moisture content to its field capacity plus 10% as leaching requirements. Irrigation water applied was calculated according to the following equation Michael; (1978).

$$d = D \times B_d \times \frac{F_c - M_c}{100}$$

Where:

d= amount of water to be applied during an irrigation event, cm.

D = soil depth within the root zone, 60 cm.

Bd= soil bulk density, g cm^{-3}

Fc= field capacity moisture content (% by weight).

Mc= moisture content before irrigation (% by weight).

Applied water was controlled throughout the pipe irrigation net of Water Requirement and Field Irrigation Research Department at Sids by using a value at each plot and water was measured by a measuring meter.

Water saving was calculated according to Molden (1997).

$$\text{Water saving (\%)} = 100 - \left[\frac{\text{Total irrigation of raised beds ridges m}^3\text{/fed}}{\text{Total irrigation water of traditional method m}^3\text{/fed}} \times 100 \right]$$

Water consumptive use (CU):

Water consumptive use was determined via soil samples taken from the experimental plots just before each irrigation and 48 hrs later besides at harvest, in 15 cm increment system to 60 cm depth of the soil profile. The CU was calculated according to Doorenbos *et al*. (1979) as follows:

$$CU = \frac{(Q_2 - Q_1)}{100} \times D \times Bd$$

Where:

CU = Water consumptive use, cm
Q_2 = Soil layer moisture content, wt/wt %, 48 hrs post irrigation.
Q_1 = Soil layer moisture content, wt/wt %, Just before irrigation.
D = Soil layer depth, cm
Bd = Bulk density of soil layer, g/cm^{-3}

Water use efficiency (kg/m^3):

The water use efficiency in the present work means the total fresh or dry yield of Egyptian clover in kilograms produced per cubic meter of water consumption, estimated according to Ali *et al*. (2007) as follows :-

WUE (kg/m^3) = Total fresh or dry yield (kg/fed) / consumptive use (m^3/fed)

Productivity of irrigation water (kg/m^3):

Water productivity is an efficiency term calculated as a ratio of product output over water input. The output could be biological goods such as crop grain, fodder, bulbs ….etc. So, water productivity in the present study is expressed as kilogram of fresh or dry forage obtained per the unit of applied irrigation water.

The water productivity values were calculated for different treatments according to FAO (2003) as follows:

WP (kg/m^3) = Total fresh or dry yield (kg/fed) / water applied (m^3/fed).

Statistical analysis:

The data of each cut and total yield in every season were statistically analyzed according to Snedecor and Cochran (1980). The difference between treatments means were compared by least significant differences test at probability level of 5% according to Gomes and Gomes (1984).

RESULTS AND DISCUSSION

Fresh and dry forage yields:

Data in Table 3 represent fresh and dry forage yields for five successive cuts as well as total cuts of two season as affected by sowing methods ., seeding rates and their interaction.

In general, fresh and dry forage yields were positively increased as the number of cutting increased up to the fourth.

Planting methods had significant effect on fresh and dry forage yields at each cut as well as total cuts in the first season also Results revealed that, sowing between in ridges (60 cm) and flat sowing methods produced the highest total fresh (56.62 and 56.32 t fed^{-1}) and dry (7.38 and 7.20 t fed^{-1}) forage yields with compared to raised bed and ridges with (no till) (54.07 and 48.52 t fed^{-1}) and (6.94 and 6.21 t fed^{-1}) for total fresh and dry forage yield., respectively.

The second season, data over seeding rate reveled that, the highest total fresh (57.50 t fed-1) and dry (7.45 t fed-1) forage yields by flat method wherever the lowest data was achieved by ridges sowing (without till) (49.30 and 6.42 t fed-1) for total fresh and dry forage yield, respectively. The previous results were in the same direct obtained by Shihata (1982) in Egypt, they reported of that, there were significant effects of planting methods on forage yield of Egyptian clovers. Radwan *et al*., (2015) also studied the effect of sowing methods on ten alfalfa Genotypes, they found that sowing method had highly significant effect on fresh and dry forage yields at each cut and total cuts.

Taking seeding rates into consideration, data in table (3) investigated that, there were positive and significant effect of seeding rate on fresh and dry forage yield at each cut and total yield in two seasons. Increasing seeding rate from 15 to 20 kg fed-1 had positively significantly increases of total fresh and dry forage yields by (8.59 and 8.10 %) and (6.62 and 5.39 %)in both season., respectively. These increases in forage yield due to increases of plant height (table 4) may be attributed to the efficient utilization of rat-Limiting resources required for plant growth and development, such as nutrient, space and light Pasumaty *et al,*. (1996). Similar results were obtained by Ross *et al* (2003) and EL-Karamany *et al,*. (2014), where reported that decline in green forage yield when seeding rate was recorded from 60 to 44 kg h-1.

Results in the same table also revealed that increasing seeding rate up to 25 kg fed-1 negatively, effected on berseem yield production in the two successive seasons, and Without significant differences between 20 kg fed-1 seed rate, this results are in the same direction with EL-Karamany *et al,*. (2014), they reported decreased forage production at higher seeding rate of 24 kg h-1 compared with 18 kg h-1.

The interaction between sowing methods and seeding rate, in the first season where results indicated significant differences on total fresh and dry forage yields in the first season, the highest on the other hand significant of total fresh 58.25 t fed^{-1} and dry 7.59 t fed^{-1} forage yields were obtained from sowing with ridges (60 cm) and received 20 kg fed^{-1} followed by the sowing by flat and sowing rate (25 kg fed^{-1}). On the other hand the lowest fresh 45.83 t fed^{-1} and dry 5.98 t fed^{-1} forage yield were resulted from treatment sowing by ridges (without tillage) with15 Kg fed^{-1} as seeding rate.

At the second season also investigate that, there were difference between the values of fresh and dry forage yield due to the interaction between sowing methods and seeding rate but did not reach significant level the higher values of forage production were belonged to treatment of sowing by flat or ridges methods and planting with 20 or 25 Kg seed fed-1. While the treatment sowing by ridges without till methods and cultivated with 15 Kg fed-1 exhibited the lowest values. These results may be due to the decrease of plant height (table 4) where seeding density is critical to the establishment of healthy and productive stand of Egyptian clover Wichman *et al*. (1991) and Ball *et al*. (2002).

Table 3. Fresh and dry forage yields (ton/fed) for Egyptian clover across five cuts yield as influenced by planting method , seeding rates and their interaction of two seasons(2017 /2018 and 2018/2019)

Planting method (P)	Seeding rates (S)	Fresh yield (ton/fed.)						Dry yield (ton/fed.)					
		Cutting number											
		I	II	III	IV	V	Total	I	II	III	IV	V	Total
First season													
P_1	S_1	11.00	11.10	11.53	12.17	8.37	54.17	1.26	1.23	1.56	1.72	1.18	6.94
	S_2	11.37	11.20	12.57	12.37	9.73	57.23	1.25	1.18	1.66	1.74	1.47	7.30
	S_3	12.40	10.73	12.87	12.80	8.77	57.57	1.47	1.17	1.69	1.78	1.27	7.36
Mean		11.59	11.01	12.32	12.44	8.96	56.32	1.32	1.19	1.64	1.75	1.31	7.20
P_2	S_1	10.83	11.90	12.50	11.03	9.00	55.27	1.36	1.30	1.65	1.58	1.36	7.25
	S_2	11.52	11.57	13.43	11.97	9.77	58.25	1.41	1.29	1.69	1.72	1.48	7.59
	S_3	10.55	10.40	12.97	12.43	9.98	56.33	1.31	1.10	1.65	1.77	1.47	7.29
Mean		10.97	11.29	12.97	11.80	9.58	56.62	1.36	1.23	1.67	1.69	1.44	7.38
P_3	S_1	10.72	9.43	10.53	9.90	9.40	49.98	1.30	1.04	1.38	1.38	1.36	6.46
	S_2	12.57	11.07	11.67	11.23	9.72	56.25	1.53	1.23	1.48	1.55	1.42	7.21
	S_3	12.57	9.37	11.97	12.23	9.83	55.97	1.53	0.96	1.51	1.67	1.49	7.16
Mean		11.95	9.96	11.39	11.12	9.65	54.07	1.46	1.08	1.46	1.53	1.42	6.94
P_4	S_1	10.23	9.27	10.13	8.77	7.43	45.83	1.24	0.98	1.34	1.28	1.15	5.98
	S_2	11.53	10.37	10.63	9.70	8.90	51.13	1.36	1.13	1.35	1.42	1.42	6.67
	S_3	10.53	9.53	10.57	10.23	9.72	48.58	1.24	0.99	1.35	1.45	1.19	6.21
Mean		10.77	9.72	10.44	9.57	8.02	48.52	1.28	1.03	1.35	1.38	1.25	6.29
Mean of Seeding rates	S_1	10.70	10.43	11.18	10.47	8.55	51.31	1.29	1.14	1.48	1.49	1.26	6.66
	S_2	11.75	11.05	12.08	11.32	9.53	55.72	1.39	1.21	1.55	1.61	1.44	7.20
	S_3	11.51	10.01	12.09	11.93	9.08	54.61	1.38	1.10	1.55	1.67	1.35	7.05
LSD,05	C	0.45	0.33	0.38	0.48	0.44	1.08	0.09	0.07	0.09	0.09	0.08	0.15
	S	0.39	0.19	0.23	0.12	0.46	0.33	0.08	0.09	N.S.	0.04	0.05	0.13
	Interaction	0.95	0.88	0.52	0.50	0.52	0.77	0.16	0.11	N.S.	N.S.	0.14	0.20
Second season													
P_1	S_1	10.63	9.20	14.33	13.05	9.43	56.65	1.00	1.21	1.63	1.66	1.58	7.08
	S_2	11.17	9.03	14.77	13.68	10.13	58.78	1.12	1.18	1.78	1.84	1.81	7.74
	S_3	11.50	9.07	13.90	13.33	9.27	57.07	1.17	1.24	1.73	1.81	1.59	7.53
Mean		11.10	9.10	14.33	13.36	9.61	57.50	1.10	1.21	1.71	1.77	1.66	7.45
P_2	S_1	9.13	8.57	13.80	11.40	9.77	52.67	0.90	1.12	1.77	1.61	1.82	7.22
	S_2	9.90	9.73	14.47	11.98	10.27	56.35	0.98	1.31	1.78	1.54	1.77	7.38
	S_3	10.93	9.47	14.37	12.02	9.53	56.32	1.12	1.31	1.66	1.65	1.59	7.32
Mean		9.99	9.26	14.21	11.80	9.86	55.11	1.00	1.25	1.74	1.60	1.73	7.31
P_3	S_1	9.83	7.77	12.20	11.82	8.70	50.32	0.98	1.08	1.58	1.64	1.67	6.95
	S_2	10.77	8.73	13.20	12.13	9.10	53.93	1.08	1.16	1.70	1.68	1.43	7.05
	S_3	11.03	8.53	13.03	11.68	8.17	52.45	1.13	1.17	1.70	1.56	1.47	7.01
Mean		10.54	8.34	12.81	11.88	8.66	52.23	1.06	1.14	1.66	1.63	1.52	7.00
P_4	S_1	8.63	8.03	12.90	9.87	8.13	47.57	0.82	1.09	1.56	1.35	1.36	6.18
	S_2	9.43	9.03	13.80	10.87	8.73	51.87	0.89	1.18	1.79	1.50	1.39	6.75
	S_3	10.50	8.97	11.40	9.77	7.83	48.47	0.99	1.22	1.43	1.37	1.33	6.34
Mean		9.52	8.68	12.70	10.17	8.23	49.30	0.90	1.17	1.59	1.41	1.36	6.42
Mean of seeding rates	S_1	9.56	8.39	13.31	11.53	9.01	51.80	0.93	1.13	1.63	1.56	1.61	6.86
	S_2	10.32	9.13	14.06	12.17	9.56	55.23	1.02	1.21	1.76	1.64	1.60	7.23
	S_3	10.99	9.01	13.18	11.70	8.70	53.58	1.10	1.23	1.63	1.60	1.49	7.05
LSD,05	C	0.48	0.53	N.S.	0.48	0.52	2.61	N.S.	0.08	N.S.	0.06	0.20	0.41
	S	0.30	0.32	N.S.	0.42	0.55	2.51	0.04	0.06	N.S.	N.S.	N.S.	N.S.
	Interaction	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.15	N.S.	N.S.	N.S.	0.17	N.S.

(P_1,P_2,P_3 and P_4) Planting method: Flat, ridges, raised beds and ridges (without tillage) sowing; (S_1, S_2 and S_3) Seeding rates: 15, 20 and 25 kg seeds/fed, respectively.

Plant height and leaves / stem ratio

The effect of sowing methods and seeding rate and their interaction on plant height and leaves / stem ratio in two seasons are summarized in table (4). Regarding to sowing methods, results revealed that there were significant effects of sowing methods on plant height in all cuts in two successive seasons expect the second cut in the first season. In general the highest values of plant height as an averages of five cuts were belonged to (78.22 cm) raised bed method. The lowest plant height on averages was related to sowing by ridge (no tillage) (72.78 cm) in the first season. On the other side at the second season, the traditional farmer flat method significantly surpassed other there different methods of plant height as an averages all cuts which recorded (76.80 cm) followed by ridges (74.84 cm), but the lowest average of plant height (71.62 cm) was obtained from sowing with raised bed.

Our result are in the same direction with Ibrahim *et al* (2014) and Hamdalla *et al* (2013) they reported that a significant effect of sowing method on plant height of alfalfa. Radwan *et al*. (2015) also found that sowing method had highly significant effect on plant height in some cuts of alfalfa.

Data in table (4) investigate that there were significant effect of seeding rate on plant height in all cuts and their means in the two seasons except the fourth and fifth cut in the first and fourth in the second season on average. On average increasing seeding rate from 15 to 20 kg fed^{-1} led to positive and significant increase of an average of plant height from 77.28 to 79.72 cm in the first season and from 73.3 to 75.5 cm in the second season. These results may be due to the more completion for light or nutrients, which led to elongation of plant Imam and Ranjbar (2002), also Bakheit *et al*. (2012) indicated that under the reduction

in light penetration through middle and lower layes of shoots, the auxins decimation led to increase of plant height.

Similar results were obtained by Kandil *et al*. (2004) and Salem *et al.* (2019). The interaction between sowing methods and seeding rate had insignificant effect on plant height this mean that each factor affect separate. But generally sowing berseem by ridges with 20 kg seed fed^{-1} gave the highest value of plant height compared to sowing by ridges (without till) with 15 kg seed fed^{-1} which recorded the shortest plants.

Table 4. Berseem clover plant height and leaves/stem ratio (wt/wt) for five cut as influenced by planting method , seeding rates and their interaction of two seasons (2017 /2018 and 2018/2019).

Planting method (P)	Seeding rates (S)	plant height (cm)						Leaves/stem ratio					
		Cutting number											
		I	II	III	IV	V	Mean	I	II	III	IV	V	Mean
First season													
P_1	S_1	65.33	78.67	85.67	83.67	75.67	77.80	0.40	0.45	0.47	0.40	0.39	0.42
	S_2	67.67	80.33	88.00	85.33	77.67	79.80	0.44	0.49	0.46	0.42	0.43	0.45
	S_3	73.00	77.00	91.67	77.33	79.00	79.60	0.47	0.42	0.47	0.47	0.41	0.45
Mean		68.67	78.67	88.44	82.11	77.44	77.44	0.44	0.45	0.47	0.43	0.41	0.44
P_2	S_1	68.00	79.00	89.00	78.00	76.67	78.13	0.47	0.46	0.43	0.49	0.40	0.45
	S_2	72.67	83.33	94.67	76.00	77.00	80.73	0.50	0.50	0.51	0.48	0.44	0.48
	S_3	67.00	79.33	92.67	81.67	78.67	79.87	0.44	0.41	0.47	0.46	0.46	0.45
Mean		69.22	80.56	92.11	78.56	77.44	77.44	0.47	0.46	0.47	0.48	0.43	0.46
P_3	S_1	61.33	78.33	95.00	75.33	76.33	77.27	0.43	0.43	0.44	0.47	0.42	0.44
	S_2	67.00	81.67	97.00	76.33	71.33	78.67	0.48	0.47	0.49	0.45	0.51	0.48
	S_3	66.67	76.00	98.33	80.33	72.33	78.73	0.47	0.41	0.51	0.46	0.37	0.45
Mean		65.00	78.67	96.78	77.33	73.33	78.22	0.46	0.43	0.48	0.46	0.44	0.46
P_4	S_1	63.67	77.67	95.00	73.67	69.67	75.93	0.45	0.42	0.40	0.50	0.42	0.44
	S_2	68.67	81.00	98.00	78.33	72.33	79.67	0.49	0.48	0.46	0.46	0.46	0.47
	S_3	66.67	79.67	96.67	75.00	76.33	78.87	0.48	0.43	0.43	0.45	0.39	0.44
Mean		66.33	79.44	96.56	75.67	72.78	72.78	0.47	0.44	0.43	0.47	0.42	0.45
Mean of Seeding rates	S_1	64.58	78.42	91.17	77.67	74.58	77.28	0.44	0.44	0.43	0.47	0.41	0.44
	S_2	69.00	81.58	94.42	79.00	74.58	79.72	0.48	0.49	0.48	0.45	0.46	0.47
	S_3	68.33	78.00	94.83	78.58	76.58	79.27	0.47	0.42	0.47	0.46	0.41	0.45
LSD,05	C	2.73	N.S.	1.77	2.15	2.47	N.S.	0.02	N.S.	N.S.	N.S.	N.S.	0.01
	S	1.60	1.46	3.13	N.S.	N.S.	0.87	0.02	0.02	0.02	N.S.	0.02	0.01
	Interaction	3.10	N.S.	N.S.	5.75	N.S.	N.S.	0.03	N.S.	0.04	0.04	0.03	N.S.
Second season													
P_1	S_1	67.67	70.67	83.00	80.33	80.67	76.47	0.60	0.60	0.38	0.42	0.50	0.46
	S_2	69.00	68.33	83.67	84.67	81.67	77.47	0.50	0.50	0.39	0.46	0.53	0.48
	S_3	70.33	69.33	82.00	80.33	80.33	76.47	0.49	0.49	0.36	0.48	0.47	0.46
Mean		69.00	69.44	82.89	81.78	80.89	76.80	0.53	0.53	0.38	0.49	0.50	0.47
P_2	S_1	60.33	65.67	80.00	79.00	82.67	73.53	0.48	0.48	0.38	0.42	0.46	0.44
	S_2	62.67	69.33	82.00	82.00	83.33	75.87	0.57	0.57	0.42	0.48	0.50	0.49
	S_3	64.67	68.33	78.33	84.00	80.33	75.13	0.60	0.60	0.41	0.44	0.45	0.48
Mean		62.56	67.78	80.11	81.67	82.11	74.84	0.55	0.55	0.40	0.45	0.47	0.47
P_3	S_1	61.67	64.00	76.67	76.00	74.00	70.47	0.43	0.43	0.42	0.48	0.46	0.45
	S_2	63.33	66.00	80.00	81.00	75.67	73.20	0.46	0.47	0.47	0.42	0.53	0.49
	S_3	64.67	65.33	78.33	74.33	73.33	71.20	0.45	0.45	0.42	0.47	0.45	0.46
Mean		63.22	65.11	78.33	77.11	74.33	71.62	0.45	0.45	0.44	0.49	0.48	0.46
P_4	S_1	66.33	64.67	77.33	77.67	77.76	72.73	0.48	0.46	0.47	0.45	0.49	0.47
	S_2	68.67	67.00	80.00	80.67	81.00	75.47	0.55	0.55	0.49	0.49	0.51	0.50
	S_3	71.67	65.33	77.33	74.67	76.33	73.07	0.48	0.48	0.45	0.46	0.46	0.47
Mean		68.89	65.67	78.22	77.67	78.33	73.75	0.50	0.50	0.47	0.47	0.49	0.48
Mean of seeding rates	S_1	64.00	66.25	79.25	78.25	78.75	73.30	0.50	0.50	0.41	0.44	0.48	0.45
	S_2	65.92	67.67	81.42	82.08	80.42	75.50	0.52	0.52	0.44	0.51	0.52	0.49
	S_3	67.83	67.08	79.00	78.33	77.58	73.97	0.51	0.51	0.41	0.46	0.46	0.47
LSD,05	C	0.88	2.59	2.80	3.63	1.13	1.43	N.S.	0.03	0.02	N.S.	N.S.	N.S.
	S	1.57	0.95	1.55	N.S.	1.72	0.95	0.02	N.S.	0.02	0.02	0.01	0.01
	Interaction	N.S.	N.S.	N.S.	2.49	N.S.	N.S.	N.S.	0.06	0.02	0.04	N.S.	N.S.

(P_1,P_2,P_3 and P_4) Planting method: Flat, ridges, raised beds and ridges (without tillage) sowing; (S_1, S_2 and S_3) Seeding rates: 15, 20 and 25 kg seeds/fed, respectively.

Leaves / stem ratio

Results in table (4) indicated that there was significant effect of sowing methods at first cut only and on average of five cuts at the first season. However at the second season, it was significant effect at second and third cuts.

Sowing methods show in constant effect during growing seasons. At first season, sowing with ridges and raised beds gave similar values of leaves / stem ratio (0.46) over the five cuts. Followed by ridges (no till) (0.45) and flat (0.44).

On the other hand, at the second season no significant effect was noticed among means values of leaves / stem ratio this due to sowing methods.

Also data in table (4) indicated that there was positive and significant effect of seeding rate on leaves / stem ratio treatment in all cuts as well as on average of five cuts in both seasons. increasing seeding rate from 15 to 20 kg fed^{-1} revealed significantly increase on average of leaves / stem ratio from 0.44 to 0.47 at the first season and from 0.45 to 0.49 at the second season on the other hand the future more rise of seeding rate to 25 kg fed^{-1} led to negative and significant effect on leaves / stem ratio.

Data showed that decrease of the average values reached from 0.47 to 0.45 and from 0.49 to 0.47 at first and second season. Respectively. This reduction may be due to both soil fertility and moisture was not enough to higher plant population. Similar results were obtained by Kandil *et al*. (2004) and Salem *et al*. (2019) regarding to the interaction between sowing methods and seeding rate results from table (4) investigate clearly that, there was no significant effect on leaves / stem ratio in the second cut and on average total five cuts in the first season and in the first and fifth cuts as well as the average total cuts in the second season. But still sowing between by 20 kg fed^{-1} under any method of sowing understudy gave the highest values of leaves / stem ratio.

In this connection, Imam and Rangbar (2000) reported that plant height and leave / stem ratio affected by the environment factors.

Applied irrigation water:

Data in Table (5) represent the effect of planting method, seeding rates on applied water in cm and m^3\fed as well as saving water in the two growing seasons and the mean of the two seasons. Concerning the effect of planting method, the results obtained reveal that the highest applied water of 3665 m^3\fed (87.26 cm) in the first season, 3590 m^3\fed (85.48 cm) in the second one, and 3628 m^3\fed (86.38 cm) for the mean of the two seasons were achieved under the traditional flat planting method (P1). Whereas, the raised bed method recorded the lowest applied water (3148 m^3\fed (74.95 cm), 3020 m^3\fed (71.90 cm) and 3084 m^3\fed (73.43 cm) in the abovementioned order. It is obvious to observe that raised bed can saving about 15.0% water in comparison to the traditional method.

Table 5. Amount of applied irrigation water under different planting method and seeding rates in 2017/2018 and 2018/2019 seasons.

Planting method	Seeding rates	First season		Second season		Mean		Mean saving water (%)
		cm	m^3/fed	cm	m^3/fed	cm	m^3/fed	
P_1	S_1	85.86	3606	85.12	3575	85.49	3591	0.00
	S_2	87.74	3685	85.48	3590	86.62	3638	0.00
	S_3	88.19	3704	85.83	3605	87.02	3655	0.00
Mean		87.26	3665	85.48	3590	86.38	3628	0.00
P_2	S_1	80.98	3401	78.33	3290	79.66	3346	6.82
	S_2	82.71	3474	81.79	3435	82.25	3455	5.03
	S_3	83.43	3504	82.38	3460	82.91	3482	4.73
Mean		82.37	3459	80.83	3395	81.60	3427	5.53
P_3	S_1	73.38	3082	69.05	2900	71.22	2991	16.71
	S_2	75.02	3151	73.21	3075	74.12	3113	14.43
	S_3	76.43	3210	73.45	3085	74.94	3148	13.87
Mean		74.95	3148	71.90	3020	73.43	3084	15.00
P_4	S_1	76.19	3200	74.64	3135	75.42	3168	11.78
	S_2	78.29	3288	76.79	3225	77.54	3257	10.47
	S_3	81.10	3406	77.74	3265	79.42	3336	8.73
Mean		78.52	3298	76.39	3208	77.46	3253	10.33
Mean of seeding rates	S_1	79.10	3322	76.79	3225	77.95	3274	11.77
	S_2	80.94	3400	79.32	3331	80.13	3366	9.98
	S_3	82.29	3456	79.86	3354	81.07	3405	9.11

(P_1,P_2,P_3 and P_4) Planting method: Flat, ridges, raised beds and ridges (without tillage) sowing; (S_1, S_2 and S_3) Seeding rates: 15, 20 and 25 kg seeds/fed, respectively.

The superiority of raised bed method in saving water can explained by the water was added in furrow as in raised bed, the area of furrow in raised bed is lower than other planting methods, consequently, received less irrigation water Mollah *et al.* (2009). In this concern, Swelem *et al.* (2013) indicated that raised bed regulate the water distribution through lowering water losses by reducing water evapotranspiration, deep infiltration and surface water run off and seepage. These results are in line with those obtained by Zhang *et al.* (2007) for wheat plant and Karima and Hassan (2019) for barley plant.

As for seeding rates, the data clearly show that as the seeding rate increased, the amount of applied water increased, while the saving water decreased in the both growing seasons. The applied water under 15 kg seeds/fed decreased by about 3.9 and 3.8% over the treatment of 25 kg seeds/fed in both seasons, respectively. Whereas the increment in the mean saving applied water due to the lowest seeding rates reached to 29.2% when compared with the treatment of higher seeding rate. In this convection, Sayyed *et al.* (2012) reported that increasing seeding rates resulted in significant increases in plant population and yield of clover, hence need more of water. In general, the data in Table (5) indicate that the clover plant cultivated with 15 kg seed/fed under raised bed method recorded the lowest applied water which resulted in more saving water than other treatment.

Seasonal Consumptive Use (m^3/fed.):

The data of the effect of both planting method and seeding rates on seasonal consumptive use are given Table (6). With respect to planting method, the data indicated that the total consumptive uses of Egyptian clover during the two growing seasons were significantly affected by planting method. It could be arranged the effect of planting method on seasonal consumptive use as the descending order as follow: flat > ridges > ridges without tillage > raised bed. The highest seasonal consumptive use of 2785.4 and 2728.4 m^3/fed were recorded due to the traditional flat method (P_1), while the lowest ones of 2203.4 and 2114.0 m^3/fed were obtained under the raised bed method in both seasons, respectively. It can be observed that the effect of planting method on seasonal consumptive use follows the same trend of applied water as discussed before (Table 6). These results are in line with

those obtained by Hossain *et al.* (2004) and Abou El enein *et al.* (2009).

Table 6. Water consumptive use (m^3/fed.) as affected by planting method and seeding rates in 2017/2018 and 2018/2019 growing seasons.

Planting method	Seeding rates	C.U. (m^3/fed.) First season	Second season	Mean
	S_1	2740.6	2717.0	2728.8
P_1	S_2	2800.6	2728.4	2764.5
	S_3	2815.0	2739.8	2777.4
Mean		2785.4	2728.4	2756.9
	S_1	2516.9	2434.6	2475.3
P_2	S_2	2570.9	2541.9	2556.4
	S_3	2593.0	2560.4	2576.7
Mean		2560.3	2512.3	2536.1
	S_1	2157.4	2030.0	2093.7
P_3	S_2	2205.7	2152.5	2179.1
	S_3	2247.0	2159.5	2203.3
Mean		2203.4	2114.0	2158.7
	S_1	2240.0	2194.5	2217.3
P_4	S_2	2301.6	2257.5	2279.6
	S_3	2384.2	2285.5	2334.9
Mean		2308.6	2245.8	2277.3
Mean of seeding	S_1	2413.7	2344.0	2378.9
	S_2	2469.7	2420.1	2444.9
rates	S_3	2509.8	2436.3	2473.1

(P_1,P_2,P_3 and P_4) Planting method: Flat, ridges, raised beds and ridges (without tillage) sowing; (S_1, S_2 and S_3) Seeding rates: 15, 20 and 25 kg seeds/fed, respectively.

Considering the effect of seeding rates, the data show that increasing seeding rates from 15 to 25 kg/fed seeds resulted in markedly increasing in seasonal consumptive use. The relative decreasing in this water incidence caused by using 15 kg/fed seeds reached to 3.8 % over using 25 kg /fed seeds in both seasons. Again, the effect of seeding rates on seasonal consumptive use is parallel to its effect on applied water, where highest seeding rates resulted in more plant population as well as fresh forage yield which absorbed greatest amount of water then other seeding rate treatments Oushy (2008).

The data of the effect of combined planting method and seeding rates reveal that the treatment of raised bed + 15 kg/fed seeding rate recorded the lowest seasonal consumptive (2157.4 and 2030.0 m^3/fed) in both growing seasons, respectively. While, the plants cultivated by using 25 kg/fed seeds and planted in the traditional flat method consumed highest amount of water (2815.0 and 2739.8 m^3/fed) in the two seasons, respectively.

Water use efficiency and water productivity:

The water efficiency or water productivity in this study, mean kg fresh or dry yield of clover forage produced due to one cubic meter of total consumed water or total applied water, respectively. The data in Table (7) represent the effect of planting method and seeding rates on this water incidence.

Table 7. Water use efficiency and water productivity (kg/m^3) as affected by planting method and seeding rate s in 2017/2018 and 2018/2019 growing seasons.

Planting method	Seeding rates	W.U.E. (kg /m^3 Water consumption) First season Fresh	First season Dry	Second season Fresh	Second season Dry	Mean Fresh	Mean Dry
	S_1	19.77	2.53	20.85	2.61	20.31	2.57
P_1	S_2	20.43	2.61	21.54	2.84	20.99	2.73
	S_3	20.45	2.61	20.83	2.75	20.64	2.68
Mean		20.22	2.58	21.07	2.73	20.65	2.66
	S_1	21.96	2.88	21.63	2.97	21.80	2.93
P_2	S_2	22.66	2.95	22.17	2.90	22.42	2.93
	S_3	21.72	2.81	22.07	2.86	21.90	2.84
Mean		22.11	2.88	21.95	2.91	22.04	2.90
	S_1	23.17	2.99	24.79	3.42	23.98	3.21
P_3	S_2	25.50	3.27	25.05	3.27	25.28	3.27
	S_3	24.91	3.19	24.29	3.25	24.60	3.22
Mean		24.53	3.15	24.71	3.31	24.62	3.23
	S_1	20.46	2.67	21.68	2.82	21.07	2.75
P_4	S_2	22.22	2.90	22.98	2.99	22.60	2.95
	S_3	20.38	2.60	21.211	2.77	20.80	2.69
Mean		21.02	2.72	21.95	2.86	21.16	2.80
Mean of seeding rates	S_1	21.34	2.77	22.24	2.96	21.79	2.87
	S_2	22.70	2.93	22.94	3.00	22.82	2.97
	S_3	21.87	2.80	22.10	2.91	21.99	2.87
		W.P. (kg /m^3 Water applied)					
	S_1	15.02	1.92	15.85	1.98	15.44	1.95
P_1	S_2	15.53	1.98	16.37	2.16	15.95	2.07
	S_3	15.54	1.99	15.83	2.09	15.69	2.04
Mean		15.36	1.96	16.02	2.08	15.69	2.02
	S_1	16.25	2.13	16.01	2.19	16.13	2.16
P_2	S_2	16.77	2.18	16.40	2.15	16.59	2.17
	S_3	16.08	2.08	16.28	2.12	16.18	2.10
Mean		16.37	2.13	16.23	2.15	16.30	2.14
	S_1	16.22	2.10	17.35	2.40	16.79	2.25
P_3	S_2	17.85	2.29	17.54	2.29	17.70	2.29
	S_3	17.44	2.23	17.00	2.27	17.22	2.25
Mean		17.17	2.20	17.29	2.32	17.24	2.26
	S_1	14.32	1.87	16.05	1.97	15.19	1.92
P_4	S_2	15.55	2.03	17.72	2.09	16.64	2.06
	S_3	14.26	1.82	16.06	1.94	15.16	1.88
Mean		14.71	1.91	16.28	2.00	15.66	1.95
Mean of seeding rates	S_1	15.45	2.01	16.32	2.14	15.89	2.08
	S_2	16.43	2.12	17.01	2.17	16.72	2.15
	S_3	15.83	2.03	16.29	2.11	16.06	2.07

(P_1,P_2,P_3 and P_4) Planting method: Flat, ridges, raised beds and ridges (without tillage) sowing; (S_1, S_2 and S_3) Seeding rates: 15, 20 and 25 kg seeds/fed, respectively.

Considering the planting method, the obtained results indicate that the best water use efficiency and productivity, whether as fresh or dry weight basis were obtained under raised bed method fallowed by ridges method, while the

traditional farmer flat method recorded the lowest ones in both seasons. The superiority of raised bed method on these traits than other planting method is mainly du to its positive effect on reducing consumptive and applied water as discussed earlier in Tables (5 and 6). These results are in line with those obtained by Aboulenien *et al.* (2010) and Ouda *et al.* (2010).

With regard to seeding rates, the data show that both water consumptive use and water productivity were significantly affected by seeding rates, where 20 kg seeds /fed exhibited the highest values of these traits. On the other hand, 15 and 25 kg/fed seeds had nearly the same effect on these traits, whether on fresh or dry weight basis. The increment of water use efficiency or water productivity caused by 20 kg seeds/fed can explained by its positive effect on fresh or dry yield of forage clover (Table 3).

The data of the combined effect of both planting method and seeding rates indicate that the treatment of cultivated clover plant with 20 kg/fed seeds on raised bed resulted in highest values of water use efficiency and wand water productivity, while the treatment of flat method when cultivated with 15 or 25 kg/fed seeds recorded in the lowest ones.

Recommendation

It could be recommended to use raised bed (120 cm) with 15 or 20 kg seeds/fed, while in case of present sufficient water it could be recommended to cultivate Egyptian clover on flat or ridges with 20 kg seeds/fed seeding rate.

CONCLUSION

In respect to the results of this study under deficit water resources, recommended to use raised bed (120 cm) with 15 or 20 kg seeds/fed to reducing applied water, consequently saving water during growing clover, while in case of present sufficient water it could be recommended to cultivated Egyptian clover on flat or ridges with 20 kg seeds/fed to maximum fresh and dry yield of clover.

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تأثير طرق الزراعة ومعدلات التقاوى على إنتاجية البرسيم المصرى وبعض العلاقات المائية

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الملخص

أقيمت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسدس خلال موسمى ٢٠١٨/٢٠١٧ ، ٢٠١٩/٢٠١٨ لدراسة تأثير طرق الزراعة (أرض مستوية ، خطوط بعرض ٦٠ سم ، مصاطب بعرض ١٢٠ سم ، خطوط بعرض ٦٠ سم بدون خدمة) ومعدلات التقاوى (١٥، ٢٠ ,٢٥ كجم /فدان) على المحصول ومكوناته وبعض العلاقات المائية للبرسيم المصرى وكانت أهم النتائج كما يلى : أدت معاملة الزراعة على أرض مستويه أو على خطوط بمعدل ٢٠كجم بذور للفدان للحصول على أعلى القيم لصفات ارتفاع النبات ، والنسبة بين وزن الأوراق الى وزن الساق، والمحصول الطازج والجاف وكفاءة إستخدام المياه. أدت الزراعة التقليديه على أرض مستويه والزراعة على خطوط ٦٠ سم الى زيادة ارتفاع النبات والنسبه بين وزن الأوراق ووزن الساق (على أساس الوزن الطازج) والمحصول الطازج والجاف فى الخمس حشات والكلى عن باقى المعاملات ، بينما أدت الزراعة بمعدل ٢٠ كجم /فدان بذور الى الحصول على أعلى القيم لتلك الصفات. أدت الزراعة على مصاطب بعرض ١٢٠ سم وعلى خطوط بعرض ٦٠ سم إلى تقليل كمية المياه الكليه المضافه والاستهلاك المائى خلال موسم نمو البرسيم ، بينما أدت زياده معدل التقاوى المستخدمه فى الزراعة من ١٥ الى ٢٠ كجم/فدان الى زياده كمية المياه المضافه والمستهلكه. سجلت الزراعة على مصاطب أعلى قيم لكفاءة إستخدام المياه وأعلى قيم لانتاجية وحدة المياه على أساس الوزن الطازج والجاف. كما أدت الزراعة بمعدل ٢٠كجم /فدان من البذور لأعلى قيم لتلك العلاقتين المائيتين أدت معاملة الزراعة على مصاطب بمعدل ١٥ أو٢٠ كجم بذور/فدان لأقل القيم من المياه الكلية المضافة ، والمياه الكلية المستهلكة وأعلى كمية توفير من المياه. من نتائج البحث يمكن التوصية بأنه فى حاله عدم توفر المياه بالكمية المطلوبة يمكن التوصية بزراعة البرسيم المصرى على مصاطب بعرض ١٢٠ سم بمعدل تقاوى ١٥ أو ٢٠ كجم بذور للفدان لزيادة الإنتاجية تحت ظروف محافظة بنى سويف، مصر ، أما فى حاله توفر المياه يوصى بزراعة البرسيم بالطريقة التقليدية على أرض مستوية أو على خطوط بمعدل ٢٠ كجم بذور/فدان .