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Effect of Planting Date and Seeding Rate on Growth Characters, Forage Quality and Seed Yield of Forage Cowpea (*Vigna unguiculata* L.) under Drip Irrigation in New Reclaimed Soil in South Egypt

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ABSTRACT

A field experiment was conducted at Al-Marashda Research Station, Agriculture Research Center, Upper Egypt, Qena Governorate, Egypt through the two summer seasons of the year 2020 and 2021 under drip irrigation system in new reclaimed soil. The objectives of this study were to investigate the influence of dates of planting and seeding rate on forage yield and quality, seed yield and its components of forage cowpea (Sids 19 cv.). Three planting dates have been followed (1st April, 15th April and 1st May) with three seeding rate (7.5, 10 and 12.5 kg fed^{-1}). The results indicated that, planting on 1st April with seeding rate of 12.5 kg fed^{-1} gave the highest significant values in plant height, number of branches plant^{-1}, number of leaves plant^{-1}, fresh leaf/stem ratio, fresh and dry forage yield, pod length (cm), number of pods plant^{-1}, number of seeds pod^{-1}, 100- seed weight (g), seed yield (kg fed^{-1}), strew yield (kg fed^{-1}), biological yield (kg fed^{-1}) and harvest index (%). While the reverse was obtained by planting on 1st May with the seeding rate of 7.5 kg fed^{-1}. Planting on 1st April increased all chemical characters i.e., Crude Protein (%) and digestible crude protein (DCP%) content of cowpea plants under seeding rate of 12.5 kg fed^{-1}, except Crude Fiber (%) which gave the highest value by planting in 1st May with the seeding rate of 7.5 kg fed^{-1}.

Keywords: Cowpea, (*Vigna unguiculata* L.), Planting dates, Seeding rates, Forage yield and quality, Seed yield.

1. Introduction

There are some favorable newly reclaimed lands in Egypt. Reclamation and utilization of the desert areas of seliceus and calcareous soil in nature is the only hope for overcome the agricultural needs. The strategy of Qena Governorate for the horizontal expansion in agriculture needs more suitable land resources than the current existent. The western desert outskirts of Qena Governorate represent one of the main available land resources. One of the suggested area for soil reclamation is Al-Marashda village west Qena which has high store of artesian water from multilayer of Nubian sand store aquifer system. In this respect, Al-Marashda represents large land resources and a good hope for agriculture expansion. In this region, weather is hot and dry, and cultivation is depended mainly on underground water. So agriculture expansion in this case needs special managements for preferable use of land and water resources.

The demand for summer forage crops of good quality for livestock has vigorously increased in recent years. In this subject, cowpea (*Vigna unguiculata* L. Walp) is one of the main summer annual legume forage crop valuable and promising to be cultivated in the equatorial and semi equatorial regions of the world, existence the main source of food proteins, calories, dietary fiber, minerals and vitamins for a great part of the world's population (Phillips *et al.,* 2003; Kamai *et al.,* 2014 and Olusanya *et al.,* 2016). In addition to grain, cowpea can produce good yields of fodder for ruminant feeding systems Ali *et al.* (2004). Cowpea straw is a balanced nutritious feed for animals and it is a key role in animal nutrition throughout the drought period in West Africa (Singh *et al.,* 2003 and

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Ilknur *et al.,* 2012). Cowpea is well adapted to a wide range of ecological conditions and can produce better forage yield under disadvantageous conditions in the newly reclaimed soils. Such soils may adversely affect the availability of some mineral nutrients to the grown crops. In this subject Badr *et al.* (1998) mentioned that, to cultivate cowpea the reclaimed lands must define planting dates that play an important role in the productivity.

The suitable sowing dates reflect on forage and yield characters as a result of increasing the utilization efficiency from the weather factors such as rainfall temperature, relative humidity, day length among others are the determinant factors of cowpea growth and yield (Ofori and Stern, 1987; Bonny and Williams, 1992 and Lane and Majicnoon, 2017).

With respect to seeding rate that determine of the optimal plants density is essential to maximize the usage of water and nutrients per land unit area, which resulting in increasing productivity under these conditions. In this respect cowpea plant density at 224000 plants fed^{-1} gave the highest growth and yield as compared with the 84000 plants fed^{-1} (Cabrido and Verzosa, 1980; Remison, 1980; Rees, 1986; Bucag, 1987; Ohler *et al.,* 1996 and Craufurd, 2000).

The aim of this study is to identify the optimal planting date and seeding rate to produce optimum growth characters, yield, forage quality and seed yields of forage cowpea under drip irrigation in new reclaimed soil conditions.

2. Materials and Methods

A field trial was carried out during the two sequential summer seasons of the year 2020 and 2021 under drip irrigation system in new reclaimed land at Al-Marashda Research Station, West Qena Governorate, ARC, Egypt.

The objectives of this study were to investigate the exact planting date, seeding rate and their interactions under the conditions of the newly reclaimed soil on growth, forage and seed yields and its components, as well as some chemical constituents of forage cowpea (Sids 19 cv.).

The experiment was laid out in a spilt block design with four replicates. The experimental plot area was 6 m^2 (2 x 3 m). Three planting dates treatments were assigned vertical to main plots (1st April, 15th April and 1st May), whereas three seeding rates treatments were assigned to sub-plots (7.5, 10 and 12.5 kg fed^{-1}).

Soil mechanical and chemical properties of the experimental site were analyzed, according to Piper (1950) and Page *et al.,* (1982) and presented in Table (1). Chemical analyses of the irrigation water are presented in Table (2).

Table 1: Some of the physical and chemical properties of the experimental soil site of Al- Marashda Station, Qena.

Texture class	Particle size distribution			$CaCO_3$ %		EC(dSm^{-1}) (1 : 2.5)	pH (1:5)
	Sand %	Silt %	Clay %				
Sandy	81.3	12.7	6.0	12.55		3.01	8.08
Cation (meq L^{-1})				Anion (meq L^{-1})			
Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
30.02	0.88	12.0	6.2	0.0	0.82	30.6	17.9

Table 2: Chemical analysis of the irrigation water used for the experimental site of Al- Marashda Station, Qena.

TDS mg/l	pH (1 : 5)	EC (dSm^{-1}) (1 : 2.5)	Soluble cations (mg/l.)				Soluble anions (mg/l.)			
			Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^{--}	HCO_3^-	$SO4^{--}$	CL^-
225.5	7.3	3.25	28.5	8.8	31.6	6.2	24.7	110.5	41.6	31.2

The meteorological data for the experimental area obtained from Central Laboratory for Agricultural Climate (CLAC), ARC, Ministry of Agricultural and Land Reclamation (MALR), values were recorded during the two growing seasons as shown in Table (3).

Table 3: Meteorological data at Al-Marashda region, Qena Governorate during the two summer seasons of 2020 and 2021.

Months	Air temperature ^{o}C			
	2020		2021	
	Maximum	Minimum	Maximum	Minimum
April	25	16	30	16
May	43	29	37	20
June	45	31	41	22
July	44	30	39	25
August	42	31	45	32

Entire recommended farming procedures have been used; 150 kg fed^{-1} of super phosphate (15.5% P_2O_5), 45kg fed^{-1} of urea (46% N) and 100 kg fed^{-1} potassium sulphate (48% K_2O) were applied before sowing irrigation.

Only one cut was taken after 60 days from sowing then plants were left for flowering and seed production. To measure the plant growth characters, a sample of 10 plants from each plot were randomly taken.

The following characters were studied

A. Growth characteristics and forage yield: Plant height (cm), number of branches, number of leaves plant^{-1}, fresh leaf/stem ratio, fresh and dry forage yield (ton fed^{-1}).

B. Seed yield and its attributes: pod length (cm), number of pods plant^{-1}, number of seeds pod^{-1}, 100 seed weight (g), seed yield (kg fed^{-1}), strew yield (kg fed^{-1}), biological yield (kg fed^{-1}) and harvest index (%).

C. Forage quality: Plant samples were taken from the green plant cutting then oven dried at 70 °C until constant weight, followed by fine grinding to estimate Nitrogen by micro keldahl as described by Jackson (1967). Crude protein content was determined using conversion of nitrogen percentage to protein Kang *et al.* (2012). Crude protein % calculated by the equation= N% X Conversion factor (6.25). Digestible crude protein (DCP) was calculated according to Bredon *et al.* (1963) using the following equation: DCP %= 0.9596CP – 3.55.

D. Crude fiber (CF %) was determined according to A.O.A.C. (2000).

2.1. Statistical analysis

Data were statistically analyzed according to Snedecor and Cochran (1980) and treatment means were compared by least significant difference test (LSD) at 0.05 level of significance. Bartlett's test was done to test the homogeneity of error variance. The test was not significant for all assessed traits, so, the two season's data were combined.

3. Results and Discussion

3.1. Growth characteristics and forage yield

3.1.1. Effect of planting date

Results presented in Tables 4,5 and 6 clearly indicated that planting in 1st April showed highly significant increase in plant height, number of branches plant^{-1}, number of leaves plant^{-1}, fresh leaf/stem ratio, fresh and dry forage yield (ton fed^{-1}) of forage cowpea plants in the first and second seasons and in combined analysis. Data of the combined analysis showed that all mentioned characters were significantly affected by planting date. The highest values of these characters were obtained by planting in 1st April which recorded 71.08 cm for plant height, 11.28 for number of branches plant^{-1}, 45.61 for number of leaves plant^{-1}, 72.79 for fresh leaf/stem ratio, 7.33 and 1.03 ton fed^{-1} for fresh and dry forage yield . This increment in growth characters could be due to that early planting of cowpea (1st April) was more favor in maximum and minimum air temperature to plant growth (Table 3) which gave the highest values of growth characters. This increased in growth component observed in this study agreed with the findings of Ezeaku (2015) who reported that early planting date produced high vegetative growth in cowpea cultivars planted in April. This view was

supported by Shegro *et al.* (2010) who noted that early season planting assist plants to get enough moisture supply by early rains and adequate relative humidity needed for optimum growth and development of vegetative growth components of cowpea. Also, Many investigators found similar results Kurmawanshi *et al.,* (1994), Sreelatha *et al.,* (1997), Ravinder and Singh (1998), Sangakkara (1998), Begum *et al.,* (2003), Yadav (2003), Muoneke *et al.,* (2008), Bensen and Temple (2008), Abd El-Lateef *et al.,* (2009), Agbogidi and Eghog (2015), Kamara, *et al.,* (2018), Geeth (2019), Bateman *et al.,* (2020).

3.1.2. Effect of seeding rate

Results in Tables 4, 5 and 6 shows that increasing seeding rate from 7.5 to 12.5 kg fed^{-1} caused gradually increasing in plant height, number of branches plant^{-1}, number of leaves plant^{-1}, fresh leaf/stem ratio, fresh and dry forage yield (ton fed^{-1}) of forage cowpea plants in the first and second seasons and in combined analysis of the two seasons. Therefore, 12.5 kg fed^{-1} gave the highest values of all growth characters. Combined analysis clarified that all above mentioned characters were significantly affected by seeding rates, the highest values were obtained by the seeding rate of 12.5 kg fed^{-1} which recorded 62.36 cm for plant height, 9.61 for number of branches plant^{-1}, 40.95 for number of leaves plant^{-1}, 68.75 for fresh leaf/stem ratio, 7.91 and 1.08 ton fed^{-1} for fresh and dry forage yield. These results may be attributed to the intra-plant competition on nutrient and radiation. These results are in agreement with those obtained by many investigators i.e. Cabrido and Verzosa (1980), Rees (1986), Bucag (1987) and Njoku and Muoneke (2008) they reported that increasing seed rates increased growth and yield characters of cowpea.

3.1.3. Effect of interaction between planting date and seeding rate

Results in Tables 4,5 and 6 indicated that growth parameters, i.e. plant height, number of branches plant^{-1}, number of leaves plant^{-1}, fresh leaf/stem ratio fresh and dry forage yield (ton fed^{-1}) of forage cowpea plants were significantly affected by the interaction between planting date and seeding rate treatments in the first and second seasons and in combined analysis. Planting date of 1st April with seeding rate of 12.5 kg fed^{-1} significantly increased all growth characters of cowpea plants. Data of combined analysis indicated that the highest values at the interaction between 1st April and seeding rate of 12.5 kg fed^{-1} were 76.59 cm, 12.50, 52.67, 75.55, 8.94 ton fed^{-1} and 1.28 ton fed^{-1} for plant height, number of branches plant^{-1}, number of leaves plant^{-1}, fresh leaf/stem ratio, fresh and dry forage yield, respectively.

Table 4: Mean values of plant height (cm) and number of branches plant^{-1} for the fresh forage cowpea (Seasons 2020, 2021 and combined analysis) as affected by planting date and seeding rate.

Characters	Plant height (cm)			Number of branches plant^{-1}		
Treatment	2020	2021	Combined	2020	2021	Combined
Planting date						
1st April (A_1)	70.73	71.43	71.08	11.22	11.33	11.28
15th April (A_2)	59.55	56.96	58.26	8.56	8.33	8.45
1st May (A_3)	47.16	47.14	47.15	7.44	6.44	6.94
L.S.D $_{0.05}$	2.15	5.68	3.89	0.96	0.50	0.75
Seeding rate (kg fed^{-1})						
7.5 kg fed^{-1} (B_1)	55.51	53.94	54.73	8.44	8.00	8.22
10 kg fed^{-1} (B_2)	59.70	59.10	59.40	9.00	8.66	8.83
12.5 kg fed^{-1} (B_3)	62.22	62.49	62.36	9.78	9.44	9.61
L.S.D $_{0.05}$	2.38	3.81	2.75	0.43	0.58	0.41
Interaction						
A_1X B_1	66.03	67.33	66.68	10.00	10.33	10.17
A_1X B_2	69.87	70.10	69.99	11.00	11.33	11.17
A_1X B_3	76.30	76.87	76.59	12.67	12.33	12.50
A_2X B_1	56.03	51.10	53.57	8.00	8.00	8.00
A_2X B_2	61.13	58.47	59.80	8.67	8.33	8.50
A_2X B_3	61.48	61.30	61.39	9.00	8.67	8.84
A_3X B_1	44.47	43.40	43.94	7.33	5.67	6.50
A_3X B_2	48.11	48.73	48.42	7.33	6.33	6.83
A_3X B_3	48.89	49.30	49.10	7.67	7.33	7.50
L.S.D $_{0.05}$	4.12	6.60	2.33	0.73	0.36	0.30

Table 5: Mean values of number of leaves plant^{-1}and fresh leaf/stem ratio for the fresh forage cowpea (Seasons 2020, 2021 and combined analysis) as affected by planting date and seeding rate.

Characters	Number of leaves plant^{-1}			Fresh leaf/stem ratio		
Treatment	2020	2021	Combined	2020	2021	Combined
Planting date						
1st April (A_1)	44.22	47.00	45.61	69.93	75.65	72.79
15th April (A_2)	37.22	36.22	36.72	60.17	71.12	65.65
1st May (A_3)	31.00	26.67	28.84	55.22	65.38	60.30
L.S.D $_{0.05}$	2.80	5.35	4.66	4.58	3.17	4.73
Seeding rate (kg fed^{-1})						
7.5 kg fed^{-1} (B_1)	33.33	31.44	32.39	59.37	68.79	64.08
10 kg fed^{-1} (B_2)	37.56	38.11	37.84	61.24	70.57	65.91
12.5 kg fed^{-1} (B_3)	41.56	40.33	40.95	64.71	72.78	68.75
L.S.D $_{0.05}$	3.09	2.77	2.91	1.51	1.12	1.56
Interaction						
A_1X B_1	38.33	38.33	38.33	66.57	74.42	70.50
A_1X B_2	43.00	48.67	45.84	69.81	74.84	72.33
A_1X B_3	51.33	54.00	52.67	73.41	77.69	75.55
A_2X B_1	36.33	34.33	35.33	58.33	69.27	63.80
A_2X B_2	37.67	36.67	37.17	59.47	71.54	65.51
A_2X B_3	37.67	37.67	37.67	62.70	72.55	67.63
A_3X B_1	25.33	21.67	23.50	53.22	62.69	57.96
A_3X B_2	32.00	29.00	30.50	54.44	65.34	59.89
A_3X B_3	35.67	29.33	32.50	58.01	68.11	63.06
L.S.D $_{0.05}$	3.11	3.25	2.34	1.40	1.34	1.01

Table 6: Mean values of fresh and dry forage yield (ton fed^{-1}) for only one cut of forage cowpea (Seasons 2020, 2021 and combined analysis) as affected by planting date and seeding rate.

Characters	Fresh forage yield (ton fed^{-1})			Dry forage yield (ton fed^{-1})		
Treatment	2020	2021	Combined	2020	2021	Combined
Planting date						
1st April (A_1)	7.56	7.09	7.33	1.07	0.99	1.03
15th April (A_2)	6.65	6.22	6.43	0.90	0.81	0.86
1st May (A_3)	5.93	5.39	5.66	0.76	0.68	0.72
L.S.D $_{0.05}$	0.67	0.79	0.63	0.12	0.09	0.11
Seeding rate (kg fed^{-1})						
7.5 kg fed^{-1} (B_1)	5.37	4.89	5.13	0.71	0.63	0.67
10 kg fed^{-1} (B_2)	6.66	6.11	6.39	0.90	0.81	0.86
12.5 kg fed^{-1} (B_3)	8.12	7.70	7.91	1.12	1.04	1.08
L.S.D $_{0.05}$	0.78	0.38	0.41	0.15	0.22	0.13
Interaction						
A_1X B_1	6.09	5.74	5.92	0.84	0.79	0.81
A_1X B_2	7.32	6.94	7.13	1.04	0.96	1.00
A_1X B_3	9.28	8.59	8.94	1.35	1.21	1.28
A_2X B_1	5.25	5.01	5.13	0.69	0.65	0.67
A_2X B_2	6.70	6.09	6.40	0.90	0.80	0.85
A_2X B_3	7.99	7.55	7.77	1.10	1.00	1.05
A_3X B_1	4.76	3.91	4.34	0.60	0.46	0.53
A_3X B_2	5.96	5.3	5.63	0.76	0.68	0.72
A_3X B_3	7.08	6.96	7.02	0.92	0.90	0.91
L.S.D $_{0.05}$	0.35	0.26	0.41	0.11	0.16	0.21

3.2. Seed yield and its attributes

3.2.1. Effect of planting date

Data presented in Tables 7, 8 and 9 showed that planting on 1st April had a remarkable increases in pod length (cm), number of pods plant^{-1}, number of seeds pod^{-1}, 100- seed weight (g), seed yield (kg fed^{-1}), strew yield (kg fed^{-1}), biological yield (kg fed^{-1}) and harvest index (%) of cowpea as compared with planting on 15th April and 1st May in the two studied seasons and in the combined analysis. Data of the combined analysis showed that all above mentioned characters were significantly affected by planting dates. The highest values of these characters were obtained by planting on 1st April which recorded 10.96 cm for pod length, 32.22 for number of pods plant^{-1}, 12.33

for number of seeds pod^{-1} , 9.59g for 100- seed weight, 541.89 kg fed^{-1}for seed yield, 1873.34 kg fed^{-1} for strew yield, 2415.22 kg fed^{-1} for biological yield and 22.45 % for harvest index. The highest yield of 1st April planting date might be attributed to the suitable climatic conditions prevailing during this planting date presented in Table 3, which was reflected on the stimulation of plant growth. Also, the photosynthetic area and activity of the crop leading to better growth and yield components contributing to more seed yield might have been increased by significantly higher number of leaves in early sowing. Many studies found similar results; Kamara (1981), Yadav (2003), Akande *et al.,* (2012) and Agba *et al.,* (2022) reported that pod number and seed yield of cowpea planted in the early date were significantly greater than from other planting dates. Also, Ezueh (1982) found that grain yield of cowpea was higher in the early planting season but quality of the harvested crop was better in the late season. While, Bensen and Temple (2008), illustrated that early planted plants of cowpea yielded less seeds in the first year and more seed in the second year than late planted plants.

3.2.2. Effect of seeding rate

Data in Tables 7, 8 and 9 showed that the highest values of pod length (cm), number of pods plant^{-1}, number of seeds pod^{-1}, 100- seed weight (g), seed yield (kg fed^{-1}), strew yield (kg fed^{-1}), biological yield (kg fed^{-1}) and harvest index (%) of cowpea were obtained by the seeding rate of 12.5 kg fed^{-1}, while the lowest values of yield and its components were obtained by 7.5 kg fed^{-1}. The differences between seeding rate treatments were significant in the first and second seasons and there combined. Moreover, seed rate of 12.5 kg fed^{-1} gave the highest values of yield and its components of cowpea plants compared to the other seeding rate. The data of the combined analysis showed that all above mentioned characters were significantly affected by seeding rate. The highest values of these characters were obtained by the seeding rate of 12.5 kg fed^{-1} which recorded 10.58 cm for pod length, 27.22 for number of pods plant^{-1}, 11.84 for number of seeds pod^{-1}, 9.00g for 100- seed weight, 441.11 kg fed^{-1}for seed yield, 1684.45 kg fed^{-1} for strew yield, 2125.56 kg fed^{-1} for biological yield and 20.56 % for harvest index. These results tended to the true that increasing seed rate caused decreases the light efficient to photosynthesis, since the plant become tallest to opium the efficient light. These results are in agreement with those obtained by Cabrido and Verzosa (1980), Rees (1986), Bucag (1987), Ohler *et al.,* (1996), Ezumah and Lkeorgu (2008), Njoku and Muoneke (2008) and Taipodia and Nabam (2013).

Table 7: Mean values of pod length (cm) and number of pods plant^{-1}for forage cowpea (Seasons 2020, 2021 and combined analysis) as affected by planting date and seeding rate.

Characters	Pod length (cm)			Number of pods plant^{-1}		
Treatment	2020	2021	Combined	2020	2021	Combined
Planting date						
1st April (A_1)	10.68	11.24	10.96	32.33	32.11	32.22
15th April (A_2)	10.22	10.34	10.28	22.89	23.89	23.39
1st May (A_3)	9.95	9.59	9.77	17.45	17.78	17.62
L.S.D $_{0.05}$	0.23	0.44	0.39	3.31	2.20	3.61
Seeding rate (kg fed^{-1})						
7.5 kg fed^{-1} (B_1)	10.00	10.06	10.03	20.33	20.67	20.50
10 kg fed^{-1} (B_2)	10.33	10.47	10.40	25.00	26.00	25.50
12.5 kg fed^{-1} (B_3)	10.51	10.65	10.58	27.33	27.11	27.22
L.S.D $_{0.05}$	0.12	0.30	0.10	2.26	1.03	1.53
Interaction						
A_1X B_1	10.30	11.10	10.70	25.33	25.00	25.17
A_1X B_2	10.60	11.10	10.85	34.33	34.67	34.50
A_1X B_3	11.13	11.53	11.33	37.33	36.67	37.00
A_2X B_1	10.20	10.10	10.15	22.00	22.33	22.17
A_2X B_2	10.23	10.43	10.33	22.00	24.67	23.34
A_2X B_3	10.23	10.50	10.37	24.67	24.67	24.67
A_3X B_1	9.50	8.97	9.24	13.67	14.67	14.17
A_3X B_2	10.17	9.87	10.02	18.67	18.67	18.67
A_3X B_3	10.17	9.93	10.05	20.00	20.00	20.00
L.S.D $_{0.05}$	0.15	0.11	0.17	2.12	1.56	1.38

3.2.3. Effect of the interaction between planting date and seeding rate

Tables 7, 8 and 9 indicate that the interaction between planting date and seeding rate had a significant effected on pod length (cm), number of pods plant^{-1}, number of seeds pod^{-1}, 100- seed weight (g), seed yield (kg fed^{-1}), strew yield (kg fed^{-1}), biological yield (kg fed^{-1}) and harvest index (%) of cowpea. The highest and the lowest values of seed yield and its components were obtained by planting on 1st April with seed rate of 12.5 kg fed^{-1}and planting on 1st May with seed rate of 7.5 kg fed^{-1}, respectively. Data of combined analysis showed the highest values at the interaction between 1st April and seeding rate at 12.5 kg fed^{-1} which recorded 11.33 cm for pod length, 37.00 for number of pods plant^{-1}, 12.50 for number of seeds pod^{-1}, 10.55g for 100- seed weight, 596.67 kg fed^{-1}for seed yield, 1926.67 kg fed^{-1} for strew yield, 2523.34 kg fed^{-1} for biological yield and 23.29 % for harvest index. Similar results are in agreement with those found by Ofori and Stern (1987).

Table 8: Mean values of number of seeds pod^{-1}and 100- seed weight (g) for forage cowpea (Seasons 2020, 2021 and combined analysis) as affected by planting date and seeding rate.

Characters	Number of seeds pod^{-1}			100- seed weight (g)		
Treatment	**2020**	**2021**	**Combined**	**2020**	**2021**	**Combined**
			Planting date			
1st April (A_1)	12.22	12.44	12.33	9.77	9.41	9.59
15th April (A_2)	11.44	11.78	11.61	8.62	8.51	8.57
1st May (A_3)	10.89	10.78	10.84	7.41	7.62	7.52
L.S.D $_{0.05}$	0.42	0.58	0.47	1.10	0.77	0.81
			Seeding rate (kg fed^{-1})			
7.5 kg fed^{-1} (B_1)	11.33	11.33	11.33	8.10	8.19	8.15
10 kg fed^{-1} (B_2)	11.55	11.67	11.61	8.64	8.42	8.53
12.5 kg fed^{-1} (B_3)	11.67	12.00	11.84	9.06	8.93	9.00
L.S.D $_{0.05}$	0.10	0.29	0.17	0.35	0.18	0.29
			Interaction			
A_1X B_1	12.00	12.33	12.17	9.16	8.69	8.93
A_1X B_2	12.33	12.33	12.33	9.49	9.11	9.30
A_1X B_3	12.33	12.67	12.50	10.65	10.44	10.55
A_2X B_1	11.33	11.67	11.50	8.15	8.34	8.25
A_2X B_2	11.33	11.67	11.50	8.85	8.55	8.70
A_2X B_3	11.67	12.00	11.84	8.86	8.64	8.75
A_3X B_1	10.67	10.00	10.34	7.00	7.54	7.27
A_3X B_2	11.00	11.00	11.00	7.58	7.61	7.60
A_3X B_3	11.00	11.33	11.17	7.66	7.72	7.69
L.S.D $_{0.05}$	0.14	0.27	0.11	0.21	0.13	.007

3.3. Forage quality

3.3.1. Effect of planting date

Mean values of forage quality characters as affected by planting date in the two studied seasons and in the combined analysis are presented in Table (10). Results indicated that the differences between the treatments of planting date were significant, the highest crude protein (%) and digestible crude protein (DCP%) content in forage cowpea were obtained when planting was carried out on 1st April while crude fiber (%) gave the lowest value in this date of planting. The lowest content of all chemical characters except crude fiber (%) were observed by planting on 1st May. Data of the combined analysis showed that all above mentioned characters were significantly affected by planting dates, the highest values of these characters except crude fiber (%) were obtained by planting in 1st April recorded 17.29 for crude protein (%) and 13.04 for (DCP%) , while crude fiber % gave the lowest value at same date of planting which recorded 23.86%. This result may be due to that the microclimate on 1st April was more suitable for plants to accumulate crude protein content, digestible protein content and crude fiber in cowpea plants. Similar result was reported by Abd El-Lateef *et al.* (2009).

Table 9: Mean values of seed yield (kg fed^{-1}), strew yield (kg fed^{-1}), biological yield (kg fed^{-1}) and Harvest Index (%) for forage cowpea (Seasons 2020, 2021 and combined analysis) as affected by planting date and seeding rate.

Characters / Treatment	Seed yield (kg fed^{-1})			Strew yield (kg fed^{-1})			Biological yield (kg fed^{-1})			Harvest Index (%)		
	2020	2021	Comb.	2020	2021	Comb.	2020	2021	Comb.	2020	2021	Comb.
Planting date												
1st April (A_1)	548.22	535.55	541.89	1928.89	1817.78	1873.34	2477.11	2353.33	2415.22	22.13	22.76	22.45
15th April (A_2)	375.56	413.33	394.45	1605.00	1588.89	1596.95	1980.56	2002.22	1991.39	18.96	20.64	19.80
1st May (A_3)	240.89	240.00	240.45	1460.00	1338.89	1399.45	1700.89	1578.89	1639.89	14.16	15.20	14.68
L.S.D $_{0.05}$	34.11	52.04	61.32	56.72	49.23	62.75	86.34	75.13	81.06	2.54	1.63	2.31
Seeding rate (kg fed^{-1})												
7.5 kg fed^{-1} (B_1)	338.00	360.00	349.00	1580.55	1502.22	1541.39	1918.55	1862.22	1890.39	17.62	19.04	18.33
10 kg fed^{-1} (B_2)	386.67	386.66	386.67	1686.67	1601.11	1643.89	2073.34	1987.77	2030.56	18.65	19.04	18.85
12.5 kg fed^{-1} (B_3)	440.00	442.22	441.11	1726.67	1642.22	1684.45	2166.67	2084.44	2125.56	20.31	20.80	20.56
L.S.D $_{0.05}$	0.084	21.55	27.61	37.05	34.46	37.18	65.11	59.25	48.77	0.82	1.04	0.46
Interaction												
A_1X B_1	464.67	493.33	479.00	1853.33	1760.00	1806.67	2318.00	2253.33	2285.67	20.05	21.58	20.82
A_1X B_2	566.67	533.33	550.00	1946.67	1826.67	1886.67	2513.34	2360.00	2436.67	22.55	21.89	22.22
A_1X B_3	613.33	580.00	596.67	1986.67	1866.67	1926.67	2600.00	2446.67	2523.34	23.59	22.99	23.29
A_2X B_1	358.00	393.33	375.67	1575.00	1500.00	1537.50	1933.00	1893.33	1913.17	18.52	20.56	19.54
A_2X B_2	366.67	393.33	380.00	1593.33	1626.67	1610.00	1960.00	2020.00	1990.00	18.71	19.77	19.24
A_2X B_3	402.00	453.33	427.67	1646.67	1640.00	1643.34	2048.67	2093.33	2071.00	19.62	21.89	20.76
A_3X B_1	191.33	193.33	192.33	1313.33	1246.67	1280.00	1504.66	1440.00	1472.33	12.72	13.13	12.93
A_3X B_2	226.67	233.33	230.00	1520.00	1350.00	1435.00	1746.67	1583.33	1665.00	12.98	14.01	13.50
A_3X B_3	304.67	293.33	299.00	1546.67	1420.00	1483.34	1851.34	1713.33	1782.34	16.46	16.46	16.46
L.S.D $_{0.05}$	28.14	31.27	25.94	24.13	31.57	28.64	56.48	45.67	61.32	0.23	0.51	0.35

3.3.2. Effect of seeding rate

It is obvious from the data presented in Table (10) that increasing seeding rate up to 12.5 kg fed^{-1} significantly increased crude protein content and digestible protein content in forage cowpea. The highest values were recorded by 12.5 kg fed^{-1} treatment, whereas the lowest one was obtained in case of 7.5 kg fed^{-1} in the first and second seasons and combined analysis of 2020 and 2021 growing seasons. On the other hand, the highest value of crude fiber content was recorded with 7.5 kg fed^{-1}. Data of the combined analysis showed that all above mentioned characters were significantly affected by seeding rate, the highest values of these characters except crude fiber (%) were obtained by planting by 12.5 kg fed^{-1} recorded 16.82 for crude protein (%) and 12.60 for (DCP%), while crude fiber % gave the lowest value at same date of planting which recorded 24.70%. These results are in agreement with those found by Ahlawat and Saraf (1981) who reported that total nitrogen increased with increasing plant density of pigeon pea. While, El-Hossini (1990) showed that crude protein of leaves and stem of pigeon pea were not influenced with widening distance between hills except in the first cut for crude protein percentage of leaves.

3.3.3. Effect of interaction between planting date and seeding rate

Data presented in Table 10 showed that chemical composition, i.e. crude protein (%), digestible crude protein (DCP %) content and crude fiber (%) in forage cowpea were significantly affected by the interaction between planting date and seeding rate treatments. Planting date on 1st April with seed rate at 12.5 kg fed^{-1} interaction treatment increased all chemical characters of cowpea plants except crude fiber (%) of forage cowpea which gave the highest value by planting on 1st May with seed rate at 7.5 kg fed^{-1}. However, the lowest values of crude protein (%) and digestible crude protein (DCP %) content in forage cowpea were obtained by planted cowpea on 1st May with 7.5 kg fed^{-1}. Data of combined analysis showed the highest values at the interaction between 1st April and seed rate at 12.5 kg fed^{-1} which recorded 17.73 for crude protein (%) and 13.47 for (DCP%) , while crude fiber % gave the lowest value at same date of planting which recorded 23.48%.

Table 10: Mean values of Crude Protein (CP %), Digestible Crude Protein (DCP %) content and Crude Fiber (CF %) in forage cowpea (Seasons 2020, 2021 and combined analysis) as affected by planting date and seeding rate.

Characters	Crude protein (%)			Digestible Crude Protein (%)			Crude Fiber (%)		
Treatment	**2020**	**2021**	**Comb.**	**2020**	**2021**	**Comb.**	**2020**	**2021**	**Comb.**
Planting date									
1st April (A_1)	17.69	16.88	17.29	13.43	12.65	13.04	23.66	24.05	23.86
15th April (A_2)	16.93	16.17	16.55	12.70	11.97	12.34	24.83	25.18	25.01
1st May (A_3)	15.87	15.04	15.46	11.68	10.88	11.28	26.17	26.78	26.48
L.S.D $_{0.05}$	0.53	0.43	0.61	0.24	0.31	0.19	0.16	0.20	0.32
Seeding rate (kg fed^{-1})									
7.5 kg fed^{-1} (B_1)	16.55	15.53	16.04	12.33	11.35	11.84	25.36	25.71	25.54
10 kg fed^{-1} (B_2)	16.76	16.11	16.44	12.53	11.91	12.22	24.90	25.31	25.11
12.5 kg fed^{-1} (B_3)	17.18	16.46	16.82	12.94	12.25	12.60	24.41	24.98	24.70
L.S.D $_{0.05}$	0.15	0.21	0.27	0.11	0.26	0.14	0.21	0.25	0.29
Interaction									
A_1X B_1	17.36	16.51	16.94	13.11	12.29	12.70	24.13	24.50	24.32
A_1X B_2	17.53	16.85	17.19	13.27	12.62	12.95	23.64	23.91	23.78
A_1X B_3	18.18	17.28	17.73	13.90	13.03	13.47	23.22	23.73	23.48
A_2X B_1	16.65	15.75	16.20	12.43	11.56	12.00	25.21	25.71	25.46
A_2X B_2	16.90	16.33	16.62	12.67	12.12	12.40	24.72	25.16	24.94
A_2X B_3	17.24	16.44	16.84	12.99	12.23	12.61	24.57	24.66	24.62
A_3X B_1	15.64	14.32	14.98	11.46	10.19	10.83	26.75	26.92	26.84
A_3X B_2	15.85	15.14	15.50	11.66	10.98	11.32	26.33	26.87	26.60
A_3X B_3	16.11	15.67	15.89	11.91	11.49	11.70	25.44	26.55	26.00
L.S.D $_{0.05}$	0.26	0.11	0.08	0.10	0.06	0.17	0.10	0.04	0.20

4. Conclusion

In general, it could be concluded that, under the conditions of this investigation, it can recommended by cultivate, the forage cowpea plants Sids 19 cv. on 1st April using the seeding rate of 12.5 kg fed^{-1} to obtain superior vegetative growth character, fresh forage yield (ton fed^{-1}), seed yield (ton fed^{-1}) and its components, the best fodder quality under drip irrigation system in new reclaimed land at Al-Marashda region, West Qena Governorate.

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