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Effect of last cut date and fertilizer system on forage yield, seed productivity and its quality of Egyptian clover

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The present investigation was conducted at Kafr Al-hamam Agricultural Research Station, Agric. Research Center (ARC) and at the laboratory of the Seed Technology Research Department, Field Crops Research Institute, ARC, Giza, Egypt during the two successive seasons of 2018/2019 and 2019/2020. The study aimed to find out the effects of three last cut dates (15th March, 15th April, and 15th May) and three fertiliser systems (15kgN fad-1 and 15kgN fad-$^{1+}$ foliar spray of micronutrients) on forage yield, seed yield and its components, seed quality, and economic evaluation of Egyptian clover (Helali cultivar). A randomised complete block split-plot design with three replications was used in each season. The results of combined data from the two seasons of the investigation indicated that delaying the last cut on May 15th significantly increased seasonal fresh and dry forage yields (44.00 and 8.63 tonnes fad.-1) respectively, compared to the other cut dates. While the last cut on April 15th gave the highest value for seed yield and its components, as well as improving most quality traits. The treatments of 15kg N fad.$^{-1}$+foliar spray of micronutrients showed superiority compared to the other treatments. The interaction between the last cut and the fertiliser system had significant effects on most studied traits of the Egyptian clover crop. It could be concluded that the time of last cut on April 15 is indicated as the optimal time to last cut with applying 15 kg N fad^{-1}. +foliar spray of micronutrient for enhanced seed production and good quality with enough quantity of forage yield and the improvement of maximum income per unit area with Egyptian clover for the dual purpose. In particular, the seed can only be produced as part of the forage yield calculation. Also, noting that high-quality seed enables farmers to obtain crop stands with an economical planting rate, high emergence, vigorous seedling establishment, uniformity in crop stand, uniformity in ripening, faster growth, and high resistance to biotic and abiotic factors.

Keywords: Egyptian clover, last cut time, fertilizer system, forage yield, seed production and seed quality.

INTRODUCTION

Cultivation and production of fodder is an integral part of the agriculture system in Egypt. It is home to about 3.8 million livestock supporting 24.7 million rural families, with the primary objectives of meeting daily household dietary requirements and also supplementing incomes to improve livelihoods. But with the increase of the population in Egypt to 102,334,404 people, which is estimated to be 1.31% of the total world population and a reduction in the amount of animal protein consumed per person (Economic Reports, 2021), it is necessary to increase the per unit production of fodder crops to feed this huge population. Therefore, the demand for high-quality Egyptian clover seeds has increased dramatically in recent years as farmers realize that they will achieve greater profits by increasing the proportion of high-quality green fodder used and, thus, reducing the use of expensive concentrates.

Egyptian clover is the most important winter-season legume cultivated in an area of around 2.5 million faddan. Clover cultivars are multi-cut in nature, providing forage for a long duration in the winter and spring seasons. It is characterized by its high productivity, high adaptability in winter and excellent quality of forage on a dry matter basis. It contains 17–22% crude protein, high digestibility (up to 65%), 42–49% neutral detergent fiber, 35–38% acid detergent fiber, 24–25% cellulose and 7–10% hemicellulose, as well as high palatability and has no reported anti-quality substances (FAOSTAT, 2021). The phenomenal success of Egyptian clover in Egypt is also due to its high nitrogen-fixing ability, resulting in a substantial improvement in soil fertility. It has soil-building characteristics and improves the physical, chemical, and biological properties of the soil, resulting in better growth and yield of crops in rotation. Excess green fodder can also be converted into excellent hay or silage and utilized for the later enrichment of poor quality feeds like roughages and straw (El-Zanaty, 2005; Mohamed *et al.,* 2017).

Concerning the date of the last cut, (Karjule and Shelar, 2021) reported that a delay in the last cut may lead to a decrease in seed production due to a decrease in the number of seeds in the heads, percentage of seed set, and weight of 1000 seeds. Meteorological factors such as light period and temperature also have a significant impact on seed yield. The higher temperature led to the shorter length of the vegetative and reproductive phases and the movement of the pollinator. (Amato *et al.,* 2013) stated that the short period between the timing of the last harvest and the harvest led to immature seeds with reduced seed viability, whilst the widening of the period between the timing of the last harvest and the harvest caused the shattering of ripened seeds, resulting in seed loss. Also, a study conducted in India by (Virender and Narwal, 2000)mentioned that delaying the last forage cut from late March until mid-April increased green forage (59.2 t/ha vs. 69.3 t/ha) and DM (7.5 t/ha vs. 9.7 t/ha) yields, but decreased seed yield (315 kg/ha vs. 154 kg/ha).

Seed quality is one of the most important factors affecting the early performance and productivity of most crops. The fundamental objective of seed testing is to establish the quality level of seed. The success of any crop production depends mainly on the availability of seed, which is one of the critical inputs for agriculture. Vegetative and reproductive phases take place at the same time, leading to deprive seed setting. Because of the shortage of fodder, it is repeatedly cut for green forage, which leads to vigour loss and a reduction in nutrients stored for seed raw material (Singh, 1993). The time and method of harvesting in relation to postharvest treatment were very important in regulating and reducing seed deterioration (Gul *et al.,* 2011). Moreover, high air temperatures and low humidity coincide with pollination and fertilization (Singh et al., 2019a). Bee activity leads to poor pollination (Yadav *et al.,* 2015; Asmaa *et al.,* 2017), pollen infertility, post-fertilization, and termination of seed development (Pasumarty *et al.,* 1993), which all lead to weak seed setting. Less seed production and poor quality is due to a lack of using the recommended technology for seed yield management.

Regarding the second factor in the study, Egyptian clover needs less Nfertilizerbecause of its symbiotic relationship with Rhizobium and its subsequent ability to fix atmospheric N. The N fertilizer is only required for plant establishment prior to the formation of root nodules. Thus, it is recommended that 20 kg N/ha be applied at sowing to optimize Egyptian clover establishment (Amal *et al.,* 2014). Addition N fertilizer caused increasing forage and seed yields of Egyptian clover compared with control (Oushy, 2008). The determination of minerals and trace elements is important to enhance production efficiency in plants and foods (Dhaliwal *et al.,* 2008). Also, some of the trace elements including iron, manganese, zinc and copper are essential micronutrients with a variety of biochemical functions in all living organisms (Umran *et al.,* 2012).

Foliar spray of nutrients results in high yield and better seed quality in many crops (Bhuker *et al.,* 2019; Singh *et al.,* 2019b) found that at the reproductive stage, a nutritional spray of 2% KNO3and 100 ppm Borax (separate spray) had a substantial impact on seed yield and quality indices. Kumar *et al.* (2013) indicated that foliar application of 50 mg L−1 salicylic acid and 2% KNO3 recorded the maximum 1000-seed weight, seed yield and seed quality (germination percentage and seedling vigor index), which were significantly higher than the control. Application of potassium rates had positive effects on germination %, shoot and radical lengths, dry seedling weight, and seedling vigor of single-cut 'Fahl' Egyptian clover (Zizy and Awad, 2018). The study seeks to find the optimum date of the last cut and define the treatments of the fertilizer system as a very essential agricultural component for maximum forage and seed yields besides good quality seed.

MATERIAL AND METHODS

Site Description:

Two field experiments were conducted for two successive winter seasons of the years (2018/2019 and 2019/2020) at Kafr Al-Hamam Research Station (ARC), SharkiaGovernorate, Egypt, to study the effect of last cut date, fertilizer systems and their combinations on forage yield, seed production and seed quality as well as its economic evaluation of Egyptian clover (*TrifoliumalexandrinumL.)*.Helali cultivar was used. According to the analytical methods described by (Black *et al.,* 1982), the soil texture of the experimental site was clayey as shown in Table (2). The Meteorological data for East Delta region in 2018/2019 and 2019/2020winter seasons are shown in Table (3).

Experimental design and treatments:

The experimental design was a split-plot design with three replications, where dates of last cut were assigned to the main plots and the fertilizer systems were randomly arranged in the sub-plots. The sub-plot area was 10.5m^2 (3x3.5m).

Last cut date

The three dates of the last cut were applied on 15thMarch, 15thApril and 15thMay as shown in (Table 1)The data in this table also showed each of the number of cuts, a number of days from sowing to the last cut, periods between cuts (days) and periods from last cutto seed harvesting (days).

Fertilizersystems

Control: without fertilizer (F1).

15kg N fad.$^{-1}$ (F2).

15kg N fad.$^{-1}$+ foliar spray of micronutrients(F3).

Management and sampling

In both seasons the previous crop was rice. All recommended cultural practices for the Egyptian clover "Helali"(*Trifolium alexandrinum* L.) cultivar were applied. Seed was sown in the 1st and 2nd seasons on 2 and 8 November, respectively. The experimental field was fertilized with 100kg fad-1. In the form of Calcium superphosphate(15.5% P2O5) during the tillage state. Nitrogen fertilization treatments received 15 Kg N fed^{-1} in the form of ammonium nitrate (33.5% N) after seed germination and before first irrigation as an encouraging dose for growth. Also, the foliar fertilization by micronutrients containing 15% N, 5% K2O, 4000 ppm Zn, 400 ppm Mn, 2000 ppm Mg, 1000 ppm Fe and traces of Cu were used at a rate of 1.5 kg fad.$^{-1}$ the application time of foliar micronutrients was in two doses, the first dose after 50 days sowing and the second one after the last cut. The value of the spray was 200L of water fad.$^{-1}$ applied with hand compressed air sprayer. Four seasonal cuts were taken in each season i.e. after 70 days from sowing, 60 days after 1st cut and 30 days after 2ndand 3rd cuts. After reaching the last cut for each treatment, the plants were left until harvest for seed production as shown in Table (1).

Data recorded

A- Seasonal fresh and dry forage yields:

At time of cutting an area of 10.5 m2, was cut and weighed and fresh forage yield was calculated. Data for fresh forage yield as (ton fad-1) (fad= faddan = 4200 m2).Dry forage yield (ton fad-1.): samples of 250 g of fresh forage were oven-dried at 70ºC up to constant weight and dry forage yield fad-1. was calculated.

B- Seed yield and its components:

A sample of ten plants was chosen randomly from each of the three replications and the following measurements were recorded during harvesting: plant height (cm): number of heads plant^{-1}, number of seeds plant^{-1} and 1000- seed weight. An area of 2m^2 was harvested from each plot to determine seed yield (kg fad.$^{-1}$).

C- Seed quality:

Laboratory tests were conducted for two successive seasons after seed harvest of field experiments during 2018/2019 and2019/2020seasons to investigate the influence of last cut date of forage and fertilization system on seed viability and vigor of clover seeds. Laboratory tests were carried out at Seed Technology Research Department at Giza, ARC.

Germination test: the result of germination test is calculated as the average of three replicates. Two - hundred pure seeds of each replicate were divided into four sup replications of 50 seeds for each sup replicate were placed on Petri dishes containing filter paper soaked with distilled water. The Petri dishes were placed in an incubator at 20± 1ºC for 7 days. First count was determined three days after germination. Normal seedlings were counted according to the international rules (ISTA, 1999). Germination percentage was calculated using the following formula outlined by (Krishnasamy and Seshu, 1990).

$$\text{Germination (\%)} = \frac{number\ of\ normal\ seedling}{number\ of\ seed\ tested} x100$$

Seed vigor index: was calculated using the following formula (Copeland, 1976).

$$\text{Seed vigor index} = \frac{number\ of\ seeds\ germinated\ (first\ count)}{number\ of\ days\ to\ first\ count} + \frac{number\ of\ seeds\ germinated\ (last\ count)}{number\ of\ days\ to\ last\ count}$$

Evaluation of seedlings: Normal seedlings obtained from standard germination tests were used for seedling evaluation according to the rules of the Association of Official Seed Analysis (AOSA, 1983).

Seedling shoot and root length were measured at final count of germination test. Ten seedlings from each Petri dish were randomly selected, shoot and root length of individual seedlings were recorded. The shoot and root were also dried at 70 ºC for 72h.

The seedling vigor index was calculated using data recorded on germination percentage and seedling growth according to International Seed Testing Association (ISTA, 1985) by the formula given below:

Seedling vigor index = seedling length (cm) X germination percentage

Electrical conductivity test: The electrical conductivity (EC) of the leachate was determined according to procedures described by (ISTA, 1999). Four sub-samples of 50 seeds of each treatment were weighed to 0.001 g, then placed into Erlenmeyer flasks with 250 ml of distilled water and covered by aluminum foil, and held at 25ºC. After 24h, the electrical conductivity of the leachates was determined using Ec meter. The mean values were expressed in µScm^{-1}g^{-1}seed weight. Chemical composition: samples of about 50g of air-dried seeds were chosen randomly from two replications and fine grinding was done for estimating seed chemical composition: total nitrogen content was determined using Kjeldahl apparatus (AOAC, 2000), the atomic absorption spectrophotometer was used to determine Fe, Zn, Mn contents (ppm) in seeds according to (Cottenie *et al*., 1982). The content (%) of phosphorus and potassium in seeds was determined by using the procedure described by (AOAC, 1990).

D-Economic evaluation:

The cost of production and income analysis of Egyptian clover variety Helalifor the average of the two seasons were determined as follows. The following three criteria were used in the economic analysis: Total costs included values of production tools and requirements such as seeds, fertilizers, irrigation, labor, power, machinery and other general or different costs as well as land rent average. The rental value of the land in the study locality was assessed as the (6000L.E). The total income of the farm from forage, seed and straw yields of Egyptian clover under study factors.Net farm income of Egyptian clover production, as affected by treatments, was calculated as the difference between the forage, seed and straw yields values and the total costs according to the actual prices. All fertilizers and seed prices and the costs of all farm operations are based on the official and the actual market prices determined by Egypt Ministry of Agriculture (Economic Reports, 2020).

Statistical analysis:

The obtained data were analyzed statistically according to procedures outlined by (Snedecor and Cochran, 1989) using MSTAT-C computer software package(1986). Mean comparisons were made with an F-protected LSD at P<0.05. Before conducting a combined analysis, error variances were tested for homogeneity by using Bartlet test, (Steel *et al.,* 1997).

Table 1. Number of cuts, periods between sowing and the last cut, between cuts and between last cut and seed harvesting as influenced by date of last cut In 2018/2019 and 2019/2020**.**

Date of last cut	No. of cuts	Periods between sowing and the last cut (Days)	Periods between cuts(Days)				Periods from last cut to seed harvesting(Days)	
			1st	2nd	3rd	4th	1st season	2nd season
15th March	2	130	70	60	-	-	103	109
15th April	3	160	70	60	30	-	73	79
15th May	4	190	70	60	30	30	43	49

Table 2. Mechanical and chemical analyses of the experimental soil sites during 2018/2019 and 2019/2020 seasons

Soil characteristics	1st season	2nd Season
Mechanical analysis		
Find sand %	18.55	14.83
Silt %	26.80	28.95
Clay %	54.65	56.22
Texture	Clay	Clay
Chemical analysis		
pH	7.55	7.85
EC dS m^{-1}	2	2.3
Organic matter %	1.42	1.20
Available macronutrients (ppm)		
N	25.40	22.06
P	18.00	16,4
K	280.44	268.15

Table 3. Monthly average maximum temperature (Max.), minimum temperature (Min.), relative humidity(RH) and precipitation (P) in 2018/2019 and 2019/2020 growing seasons of Egyptian clover at the experimental site

Month	Temperature (°C)*			RH (%)	Precipitation (mm/day)	Wind speed (m/s)	Solar radiation ($MJ/m^2/day$)
	Max.	Min.	Average				
1st season							
November	26	15	20.5	59	0.43	2.12	14.15
December	21	11	16	65	0.73	2.75	10.62
January	19	9	14	68	1.29	2.94	11.95
February	23	10	16.5	62	0.27	2.03	14.36
March	28	12	20	47	0.13	2.45	20.59
April	37	20	28.5	44	0.22	2.66	26.61
May	35	19	27	43	0.01	3.14	25.75
June	37	21	29	41	0.00	3.10	29.25
2nd season							
November	28	16	22	55	0.01	2.46	14.53
December	21	11	16	64	1.00	3.02	11.64
January	19	7	13	56	0.27	3.00	13.01
February	21	8	14.5	59	0.28	2.57	14.82
March	23	10	16.5	56	0.55	2.93	19.22
April	28	12	20	48	0.11	3.05	23.03
May	36	17	26.5	45	0.00	3.18	27.06
June	37	22	29.5	44	0.00	3.26	28.23

*Weather data during the growing seasons were obtained from Agriculture Research Meteorological Station near the experimental site. ($MJ/m^2/day$: megajoule per square meter and per day.

RESULTS

Effect of the last cut date:

The results presented in Tables (1,4) showed significant differences in seasonal fresh and dry forage yield of both seasons as well as combined analysis, due to the different timing of last cut. Increasing the period between sowing and last cut showed significant increases in seasonal forage yield, particularly for cuttings taken in spring. On the other hand, the percentage increase in dry matter production with delay in the last cut was more than that of the green matter due to accumulation of more crude fiber and reduction in succulence.

Effect of fertilizer system:

From the same Table (4) revealed that applying the N fertilizer as a starter dose 15 kg N fad.$^{-1}$ with clover plants resulted in significant increases in seasonal fresh and dry forage yields compared to without N. It is since the addition of activating dose of N has resulted in large increases in nodulation, dry matter yield, and nitrogen. These results are by (Zahid *et al.,* 2010). On the other hand, the superiority of adding 15 kg N fad$^{.-1}$ with foliar spray of micronutrients treatment in-season fresh and dry forage yields on a combined basis were 25.06 and 28.70% more than control, whereas 14.65 and 15.66% more than adding 15 kgN fad$^{.-1}$, respectively.

Effect of interaction:

The interaction between dates of last cut and fertilizer systems was significant in both seasons and combined analysis as shown in Table (4). The data in this table indicated that the date of the last cut on the 15th of In May, gave a greater number of cuts and significantly the highest seasonal fresh and dry productivity of clover.In addition,15 kg N fad.1 with foliar spray of micronutrients appeared to produce higher seasonal forage yield of clover plants than the other treatments. However, seasonal forage production of all dates of last cut was higher when 15 kg N fad^{-1+} micronutrients treatment was applied to seasonal forage yield. Thus, the combined data showed that the highest seasonal fresh and dry forage yields (47.40 and 9.29tonfad.-1) were achieved when clover plants were left to 15thMay as the last date for cutting and fertilized with 15kg N fad.-1 + foliar spray of micronutrients.

Table 4. Effect of last cut date and fertilizer system on seasonal fresh and dry forage yields of first and second seasons and combined.

Main effects and interactions	Seasonal fresh forage yield (ton fad.$^{-1}$)			Seasonal dry forage yield(ton fad.$^{-1}$)		
	1st season	2nd season	Com.	1st season	2nd season	Com.
Last cut date (D)						
15th March (D1)	26.14	27.76	26.95	3.43	3.49	3.46
15th April (D2)	38.38	41.26	39.82	6.77	7.67	7.22
15th May (D3)	42.38	45.61	44.00	8.14	9.13	8.63
LSD $_{0.05}$	1.99	3.00	1.24	0.16	0.41	0.17
Fertilizer system: (F)						
Control (F1)	31.99	34.31	33.15	5.40	5.95	5.68
15kg Nfad.$^{-1}$(F2)	34.42	37.91	36.16	5.91	6.74	6.32
15kg Nfad.$^{-1}$ + foliar spray of micronutrients (F3)	40.50	42.41	41.46	7.03	7.59	7.31
LSD $_{0.05}$	0.64	1.26	0.73	0.15	0.34	0.22
Interaction (DXF)						
D1F1	22.15	23.01	22.58	2.88	2.89	2.88
D1F2	24.22	27.23	25.72	3.04	3.42	3.23
D1F3	32.07	33.04	32.56	4.37	4.15	4.26
D2F1	34.72	37.02	35.87	6.01	6.51	6.26
D2F2	37.69	40.66	39.17	6.57	7.48	7.03
D2F3	42.72	46.11	44.42	7.74	9.01	8.37
D3F1	39.09	42.91	41.00	7.33	8.46	7.89
D3F2	41.36	45.83	43.59	8.11	9.33	8.72
D3F3	46.70	48.09	47.40	8.98	9.61	9.29
LSD $_{0.05}$	1.11	2.18	1.27	0.27	0.60	0.39

B- Seed yield and its components:

Effect of last cutdat:

Data presented in Tables (5,6) showed the effect of last cut date and fertilizer system on seed yield and its components in the two seasons and their combined data. The 15th April last cut date gave the highest values of number of shoot/ plant, number of head/ plant, number of seed/ head, 1000 weight of seed and seed yield fad.-1traits.

Effect of fertilizer system:

Results cited in Tables (5) and (6) showed the effect of fertilizer systems on seed yield and its component in both seasons and their combined analysis. The fertilization treatments resulted in significant increments respecting all seed yield and its components under study. Whereas, the use of 15 kg N fad.$^{-1}$ + foliar spray of micronutrients to clover increased seed yield with about 21.31 and 14.00% in combined data as compared to the control and adding 15 kg N fad.$^{-1}$, respectively.

Effect of interaction:

The interactions between the dates of the last cut and fertilizer systems on seed yield and seed component of clover are presented in Tables (5,6). Seed yield and seed components characters except number of shoot plant^{-1}of clover were significantly influenced due to the different combinations between the dates of last cut and fertilizer systems. A number of head plant^{-1}(42.17), number of seed head^{-1}(66.95) and seed yield fad.$^{-1}$ (512.24 kg) characters were significantly superior in the last cut on 15th April with foliar sprayand15 kg N fad.$^{-1}$compared to other interactions between the study factors. While the lowest values of seed yield and its components were produced by a delay in last cut on 15th May without fertilizer treatment of clover.

Table 5. Effect of last cut date and fertilizer system on plant height (cm),number of shoot plant^{-1} and number of head plant^{-1} of first and second seasons and their combined.

Main effects and interactions	Plant height (cm)			No. of shoot plant^{-1}			No. of head plant^{-1}		
	1st season	2nd season	Com.	1st season	2nd season	Com.	1st season	2nd season	Com.
Last cut date (D)									
15th March (D1)	99.33	87.13	93.23	202.11	249.11	225.61	22.89	21.50	22.19
15th April (D2)	83.62	75.74	79.68	298.88	306.44	302.66	35.93	38.40	37.17
15th May (D3)	63.14	62.10	62.62	146.88	149.77	148.32	19.83	14.59	17.21
LSD $_{0.05}$	7.795	5.018	5.286	11.590	27.043	27.468	2.184	2.563	2.218
Fertilizer system (F)									
Control (F1)	77.83	69.64	73.73	202.44	193.11	197.77	23.37	22.20	22.78
15kg Nfad.$^{-1}$(F2)	80.91	74.84	77.87	220.77	236.11	228.44	25.26	22.92	24.09
15kg Nfad.$^{-1}$ + foliar spray of micronutrients (F3)	87.35	80.48	83.92	224.66	276.11	250.38	30.02	29.38	29.70
LSD $_{0.05}$	3.757	3.658	2.515	7.867	10.555	16.456	0.754	1.505	0.975
Interaction (DXF)									
D1F1	95.30	81.36	88.33	190.33	207.00	198.66	19.71	20.22	19.96
D 1F2	98.43	84.33	91.38	205.66	258.66	232.16	22.25	20.47	21.36
D1F3	104.26	95.70	99.98	210.33	281.66	245.99	26.70	23.82	25.26
D2F1	77.20	67.06	72.13	283.66	258.66	271.16	32.45	34.63	33.54
D2F2	83.00	78.20	80.60	305.66	299.33	302.49	35.41	36.19	35.80
D2F3	90.66	81.96	86.31	307.33	361.33	334.33	39.94	44.40	42.17
D3F1	61.00	60.50	60.75	133.33	113.66	123.49	17.95	11.75	14.85
D3F2	61.30	62.00	61.65	151.00	150.33	150.66	18.13	12.11	15.12
D3F3	67.13	63.80	65.46	156.33	185.33	170.83	23.41	19.91	21.66
LSD $_{0.05}$	NS	6.336	4.357	NS	18.282	NS	1.306	2.607	1.690

Table 6. Effect of last cut date and fertilizer system on a number of seed head^{-1} , 1000 weight of seed (g)and seed yield (kg fad.$^{-1}$)of first and second seasons and their combined.

Main effects and interactions	No. of seed head^{-1}			1000 weight of seed (g)			Seed yield (kgfad.$^{-1}$)		
	1st season	2nd season	Com.	1st season	2nd season	Com.	1st season	2nd season	Com.
Last cut date: (D)									
15th March (D1)	37.92	39.35	38.63	2.86	2.87	2.87	399.81	457.96	428.88
15th April (D2)	60.39	63.25	61.82	2.78	2.80	2.79	461.11	482.10	471.60
15th May (D3)	25.72	19.86	22.79	2.44	2.48	2.46	197.92	216.39	207.15
LSD $_{0.05}$	3.950	2.850	3.268	0.084	0.096	0.047	27.807	16.593	18.674
Fertilizer system (F)									
Control (F1)	38.49	37.27	37.88	2.63	2.56	2.59	323.94	351.98	337.96
15kg Nfad.$^{-1}$(F2)	40.24	40.01	40.12	2.68	2.70	2.69	346.07	373.26	359.67
15kg Nfad.$^{-1}$ + foliar sprayof micronutrients (F3)	45.31	45.17	45.24	2.77	2.90	2.83	388.82	431.21	410.01
LSD $_{0.05}$	1.905	1.491	1.206	0.037	0.120	0.055	6.178	7.853	4.695
Interaction (DXF)									
D1F1	36.29	37.13	36.71	2.82	2.81	2.81	369.30	392.91	381.10
D 1F2	37.77	39.58	38.68	2.88	2.85	2.86	394.01	455.05	424.53
D1F3	39.70	41.34	40.52	2.90	2.96	2.93	436.11	525.92	481.02
D2F1	57.95	57.55	57.75	2.74	2.74	2.74	423.18	465.83	444.51
D2F2	59.40	62.14	60.77	2.76	2.79	2.77	456.88	459.26	458.07
D2F3	63.84	70.06	66.95	2.83	2.89	2.86	503.26	521.22	512.24
D3F1	21.22	17.15	19.18	2.33	2.14	2.23	179.35	197.19	188.27
D3F2	23.53	18.33	20.93	2.40	2.46	2.43	187.32	205.48	196.40
D3F3	32.40	24.11	28.25	2.58	2.86	2.72	227.09	246.48	236.78
LSD $_{0.05}$	3.299	2.582	2.090	0.065	0.207	0.095	10.701	13.601	8.133

C- Seed quality:

Effect of last cut date:

Seed viability, vigor parameters and chemical analysis as affected by the date of the last cut of Egyptian clover in both years of investigation and their combined are presented in Tables (7, 8 and 9), respectively. The results revealed that allseed viability and vigor parameters (germination %, seed vigor index, shoot length, root length, seedling vigor index, seedling fresh weight, seedling dry weight and electrical conductivity) and concentration of mineral nutrients (N%, P%, K%, Fe ppm, Zn ppm and Mn ppm) significantly affected by date of last cut during the two years and their combined except root length in the second year of investigation which didn't reach to significant level. According to the data of the combined analysis, generally, the highest values of germination %, seed vigor index, shoot length, root length, seedling vigor index, seedling fresh weight, seedling dry weight, electrical conductivity, N, P, K, Fe, Zn and Mn were obtained from seeds collected by dates of last cut on 15th April and 15th March compared by seeds collected when delayed the date of last cuttingto15th May which gave the lowest values for quality traits.

Effect of fertilizer system:

Regarding the influence of the fertilizer system on seed viability and vigor measurements and chemical analysis, the results in Tables (7, 8 and 9) showed significant differences among fertilizer systems under study in both years, and they were combined on all traits. The fertilizer system (15 kg N fad.-1 + foliar spray of micronutrients) significantly achieved the highest values of all seed viability, vigor parameters and concentration of mineral nutrients followed by the fertilizer system (15 kg N fad.-1). On the other hand, the control treatment significantly recorded the lowest values of these parameters.

Effect of interaction:

Concerning the effect of interaction between the date of the last cut for forage and fertilizer system (D x F) on seed quality parameters Tables (7, 8 and 9), results indicated that D x F affected significantly the germination %, seed vigor index, shoot length, root length, seedling dry weight, N %, P %, K %, Fe and Mn concentration, while Dx F interaction didn't affect seedling vigor index, seedling fresh weight, electrical conductivity and Zn concentration. results revealed that all dates of last cut for forage without adding fertilizer gave the lowest values of seed quality parameters. Meanwhile, the dates of last cut for forage on 15th April and 15th March appeared to record higher values of seed quality parameters when was added nitrogen fertilizer only or nitrogen fertilizer with foliar spray of micronutrients.

Table 7. Effect of last cut date and fertilizer system on germination %, seed vigor index,shoot length (cm) and root length (cm) of first and second seasons and their combined

Main effects and interactions	Germination %			Seed vigor index			Shoot length (cm)			Root length (cm)		
	1st	2nd	Com.	1st	2nd	Com.	1st	2nd	Com.	1st	2nd	Com.
Last cut date (D)												
15th March (D1)	95.55	91.33	93.44	44.83	42.52	43.67	2.51	2.67	2.59	3.32	3.33	3.32
15th April (D2)	92.40	95.60	94.00	43.27	44.83	44.05	2.23	2.27	2.25	3.00	3.43	3.21
15th May (D3)	90.00	83.55	86.77	41.96	38.67	40.31	1.75	1.86	1.81	2.60	2.54	2.57
L S $D_{0.05}$	1.632	3.471	1.735	0.890	3.940	1.534	0.279	0.249	0.249	0.282	N.S	0.363
Fertilizer system (F)												
Control (F1)	91.55	85.77	88.66	42.92	39.73	41.32	1.30	1.34	1.32	2.81	2.98	2.90
15 kg N fad.$^{-1}$(F2)	92.44	89.11	90.77	43.12	41.83	42.47	2.42	2.46	2.44	2.91	2.66	2.78
15 kg N fad.$^{-1}$ + foliar spray of micronutrients (F3)	94.00	95.55	94.77	44.01	44.46	44.23	2.77	3.01	2.89	3.20	3.65	3.42
L S $D_{0.05}$	1.895	2.795	1.700	0.733	1.321	0.817	0.101	0.192	0.094	0.221	0.205	0.205
Interaction (DXF)												
D_1F_1	95.33	88.66	92.00	44.50	40.22	42.36	1.50	1.53	1.51	3.26	3.46	3.36
D_1F_2	95.33	87.33	91.33	44.51	41.14	42.82	2.90	3.10	3.00	3.23	2.80	3.01
D_1F_3	96.00	98.00	97.00	45.48	46.22	45.85	3.13	3.40	3.26	3.46	3.73	3.60
D_2F_1	90.70	94.00	92.33	42.94	44.31	43.63	1.33	1.40	1.36	2.76	3.33	3.05
D_2F_2	92.00	94.00	93.00	43.13	43.64	43.39	2.46	2.20	2.33	3.10	3.13	3.11
D_2F_3	94.70	98.70	96.70	43.74	46.53	45.13	2.90	3.23	3.06	3.13	3.83	3.48
D_3F_1	88.66	74.66	81.66	41.32	34.66	37.99	1.06	1.10	1.08	2.40	2.16	2.28
D_3F_2	90.00	86.00	88.00	41.74	40.72	41.23	1.90	2.10	2.00	2.40	2.06	2.23
D_3F_3	91.33	90.00	90.66	42.82	40.63	41.72	2.30	2.40	2.35	3.00	3.40	3.20
LS $D_{0.05}$	N.S	4.841	2.945	N.S	2.289	1.415	0.174	0.333	0.163	N.S	N.S	0.356

Table 8. Effect of last cut date and fertilizer system on seedling vigor index, seedling fresh weight (mg), seedling dry weight (mg) and electrical conductivity ($\mu Scm^{-1}g^{-1}$) of first and second seasons and combined

Main effects and interactions	Seedling vigor index			Seedling fresh weight (mg)			Seedling dry weight (mg)			Electrical conductivity $\mu Scm^{-1}g^{-1}$		
	1st	2nd	Com.	1st	2nd	Com.	1st	2nd	Com.	1st	2nd	Com.
Last cut date (D)												
15th March (D1)	556.66	551.42	554.04	298.77	295.66	297.22	110.37	184.17	147.27	88.41	97.65	93.03
15th April (D2)	485.20	540.64	512.92	284.44	297.88	291.16	96.68	174.68	135.68	93.30	96.35	94.83
15th May (D3)	392.93	380.35	386.64	209.44	258.33	233.88	88.44	143.58	116.01	98.85	114.33	106.59
L S $D_{0.05}$	20.497	113.30	53.240	47.83	10.318	19.66	3.668	12.583	4.865	4.976	5.962	4.393
Fertilizer system (F)												
Control (F1)	376.94	380.73	378.84	164.33	216.33	190.33	84.14	123.33	103.73	99.72	120.29	110.00
15 kg N fad.$^{-1}$(F2)	494.75	454.75	474.75	287.11	296.22	291.66	98.3	167.90	133.10	94.43	99.83	97.13
15 kg N fad.$^{-1}$ + foliar spray of micronutrients (F3)	563.08	636.93	600.01	341.22	339.33	340.27	113.06	211.22	162.14	86.42	88.22	87.32
L S $D_{0.05}$	25.589	61.65	29.278	33.24	17.512	19.347	3.255	10.829	6.534	3.023	6.261	3.585
Interaction (DXF)												
D_1F_1	451.58	439.80	445.69	169.33	215.33	192.33	92.20	130.70	111.45	94.67	118.07	106.37
D_1F_2	584.66	515.40	550.03	339.66	308.00	323.83	114.03	182.26	148.15	91.04	96.52	93.78
D_1F_3	633.73	699.06	666.40	387.33	363.66	375.50	124.90	239.56	182.23	79.53	78.38	78.95
D_2F_1	371.80	435.53	403.66	200.66	220.66	210.66	84.26	125.63	104.95	99.43	113.78	106.61
D_2F_2	512.33	495.80	504.06	288.33	330.00	309.16	93.13	184.53	138.83	94.60	90.81	92.70
D_2F_3	571.46	690.60	631.03	364.33	343.00	353.66	112.66	213.9	163.28	85.88	84.47	85.18
D_3F_1	307.46	266.86	287.16	123.00	213.00	168.00	75.96	113.66	94.81	105.05	129.02	117.03
D_3F_2	387.26	353.06	370.16	233.33	250.66	242.00	87.73	136.90	112.31	97.64	112.18	104.91
D_3F_3	484.06	521.13	502.60	272.00	311.33	291.66	101.63	180.20	140.91	93.86	101.80	97.83
L S $D_{0.05}$	N.S	N.S	N.S	N.S	30.331	N.S	5.639	18.757	11.317	3.023	N.S	N.S

Table 9. Effect of lastcut date and fertilizer system on total N %, P %, K %, Fe (ppm), Zn (ppm) and Mn (ppm) of first and second seasons and combined

Main effects and interactions	**TotalN %**			**P %**			**K %**			**Fe ppm**			**Zn ppm**			**Mnppm**		
	1st	**2nd**	**Com.**	**1st**	**2nd**	**Com.**	**1st**	**2nd**	**Com.**	**1st**	**2nd**	**Com.**	**1st**	**2nd**	**Com.**	**1st**	**2nd**	**Com.**
Last cut date (D)																		
15th March (D1)	3.67	3.76	3.71	1.83	1.68	1.76	1.80	1.71	1.75	256.32	260.59	258.46	82.47	85.01	83.74	48.39	43.50	45.94
15th April (D2)	4.07	3.92	3.99	2.31	2.55	2.43	2.17	1.81	1.99	265.34	265.61	265.47	85.23	89.28	87.26	52.56	51.07	51.81
15th May (D3)	3.26	3.16	3.21	1.32	1.48	1.40	1.73	1.57	1.65	246.30	254.02	250.16	79.99	79.40	79.69	43.64	43.46	43.55
L S $D_{0.05}$	0.170	0.208	0.090	0.108	0.240	0.144	0.086	0.077	0.047	4.341	3.697	2.936	1.939	3.978	1.934	4.456	3.377	3.212
Fertilizer system (F)																		
Control (F1)	3.46	3.22	3.34	1.58	1.52	1.55	1.70	1.57	1.64	241.19	246.53	243.86	77.04	79.49	78.26	40.17	36.01	38.09
15 kg N fad.$^{-1}$(F2)	3.69	3.64	3.67	1.81	1.95	1.88	1.89	1.68	1.79	257.77	261.69	259.73	83.34	83.96	83.65	47.91	43.48	45.70
15 kg N fad.$^{-1}$ + foliar spray of micronutrients (F3)	3.85	3.97	3.91	2.08	2.24	2.16	2.10	1.84	1.97	269.00	272.00	270.50	87.31	90.24	88.78	56.50	58.54	57.32
L S $D_{0.05}$	0.115	0.115	0.072	0.116	0.107	0.074	0.094	0.072	0.042	3.518	2.660	2.243	2.801	2.517	1.845	2.375	1.997	1.288
Interaction (DXF)																		
D_1F_1	3.33	3.42	3.38	1.48	1.14	1.31	1.65	1.60	1.62	243.10	248.61	245.86	77.47	80.48	78.98	38.65	36.08	37.36
D_1F_2	3.82	3.82	3.82	1.92	1.83	1.87	1.80	1.67	1.74	260.65	260.79	260.72	83.47	84.08	83.78	47.97	41.02	44.50
D_1F_3	3.86	4.04	3.95	2.10	2.08	2.09	1.95	1.87	1.91	265.22	272.39	268.80	86.46	90.48	88.47	58.54	53.41	55.97
D_2F_1	3.95	3.55	3.75	2.00	2.33	2.16	1.82	1.64	1.73	245.14	249.37	247.26	78.77	82.49	80.63	41.00	38.50	39.75
D_2F_2	3.98	4.01	3.99	2.27	2.54	2.40	2.18	1.80	1.99	268.69	267.48	268.08	86.17	88.78	87.47	53.16	49.78	51.47
D_2F_3	4.27	4.20	4.24	2.67	2.78	2.73	2.51	1.98	2.25	282.19	279.98	281.08	90.76	96.58	93.67	63.51	64.94	64.23
D_3F_1	3.10	2.70	2.90	1.26	1.10	1.18	1.64	1.48	1.56	235.33	241.62	238.47	74.88	75.50	75.19	40.87	33.45	37.16
D_3F_2	3.26	3.11	3.18	1.26	1.49	1.37	1.70	1.58	1.64	243.98	256.81	250.40	80.37	79.03	79.70	42.62	39.65	41.13
D_3F_3	3.42	3.68	3.55	1.45	1.85	1.65	1.84	1.66	1.75	259.59	263.65	261.62	84.72	83.67	84.20	47.44	57.28	52.36
L S $D_{0.05}$	0.199	0.200	0.124	0.202	0.186	0.128	0.162	N.S	0.072	6.094	N.S	3.885	N.S	N.S	N.S	4.114	3.45	2.232

Economic evaluation:

The income analysis and benefit-cost ratio analysis of Egyptian clover are recorded in Table 10. The economic return from the Egyptian clover crop in terms of total income was also calculated by combining maximum income from both forage and seed as well as straw. It was observed that the maximum economic return came from (15th April) when applying 15kg of N fad.-1+ foliar spray of micronutrient treatment (D2 x F3). It is the time when the optimum quality of seed is obtained, which is an additional benefit.

Table 10. Interactive Effect of last cut date and fertilizer system on income analysis and benefit-cost ratio analysis of Egyptian clover (Means of two years)

Treatments (DXF)	Benefit-cost ratio analysis			
	Total income(B)	Total cost (C)	Net income	B:C ratio
D1 x F1	15891.14	11750	4141.14	1.35
D1xF2	18128.56	11888	6240.56	1.52
D1xF3	21802.11	12108	9694.11	1.80
D2xF1	21965.06	12250	9715.06	1.79
D2xF2	24241.22	12388	11853.22	1.95
D2xF3	28055.26	12608	15447.26	2.22
D3x F1	17700.16	12650	5050.16	1.39
D3xF2	20613.83	12788	7825.83	1.61
D3xF3	24307.49	13008	11299.49	1.86

DISCUSSION

It can be noticed that the greatest seasonal fresh and dry forage yields were obtained when15th May as last cut whereas, the number of cuts that reached four cuts in 190 days yielded 44 and 8.63ton fad.-1 compared with dates 15thMarch (two cuts during 130 days yielded 26.95 and 3.46ton fad.-1) and15th April (three cuts during 160 days yielded 39.82 and 7.22 ton fad.-1) on basis combined analysis, respectively. The same results were obtained by Sardana and Narwal (2000b) who found that increasing total dry fodder yields with successive delaying last cutting was also significant in both years.

The superiority of the15 kg N fad.-1+foliar spray of micronutrients treatment may be due to the fact that micronutrients play an important role in crop nutrition and thought to be necessary for plant development and production, as their role in plant auxins bio-synthesis, oxidation reduction reactions, plant nitrogen metabolism, formation of chlorophyll, respiration, chief enzyme system and photosynthesis in plants especially if the stimulating dose of element N is added to ensure the quantity of production of forage yield. (Arora and Chahal, 2007) mentioned that the application of micronutrients increases mean dry matter yield of clover significantly compared to control. Also, (Ali *et al.,* 2008) found that the uptake of micronutrients (Cu, Mn and Fe) also increased significantly with N fertilization. Therefore, use of N fertilizer has great potential for improving Egyptian clover yield and increasing nutrient uptake in Pakistan's soils. Although legumes generally do not require N fertilizer because of their symbiotic relationship with Rhizobium bacteria. In this relationship, symbiotic N-fixing bacteria invade root hairs of host plants, where they multiply and stimulate formation of root nodules (enlargements of plant cells and bacteria in intimate association. Legumes and bacteria work together to extract atmospheric N (air is 78 percent N2 but unavailable to plants) and convert it to plant-available forms within legume roots. Bacteria inside nodules convert free N to ammonia (NH3), which the host plant utilizes to make amino acids and proteins. These results are in agreement with those reported by (Amal *et al.,* 2014).

The higher seed yield and component yield obtained from the date of 15th April might be due to fewer forage cuttings resulting in higher seed yield owing to the availability of food reserves for regeneration and seed development. Whereas fewer fodder cuttings which in turn resulted in better production and translocation of photosynthates from source to sink (Karjule and Shelar, 2021). It is evident from the Table (3), that the environmental conditions are favorableas the temperature during the period from April to June 36.33-33.66 oCas (Max.) and 20- 17 oCas (Min.) with low RH 42.66 - 45.66% also, wind speed of 2.96-3.16 m/s as well as less solar radiation 27.20 - 26.10MJ/m2/day during two years of study caused activity of honey bees and enhanced the pollination which played major role in seed formation by tripping the blooms resulting in increased seed setting in clover crop Table (6). In this connection (Kumar *et al.,* 2013) concluded that proper determination date of the last cut date leads to benefit of favorable environmental conditions during growth and sufficient time will be available after forage cutting for optimum vegetative growth, attainment of bloom, pollination and seed setting. On the contrary, the lowest seed yield and its component were obtained from the date of15th May which continuation of forage cutting late in the season (until 15th May) resulted in less foliage retention and poor flowering and consequently a shorter period from the date of the last cut to seed harvesting leading to lower seed yield. Also, relative humidity and high temperatures prevailing during the reproductive and seed setting stages significantly reduce seed yield of clover. So, seed can only be produced at the expense of forage yield. (Kanwaljit and Tarandeep, 2019) reported that when the clover was subjected to high temperatures and water stress during the seed setting and filling stage, it resulted in a significant reduction in seed yield. Moreover, temperatures during the flowering stage had a great influence on seed set, yield and maturity. Several additional workers observed similar results of the delay in the last cut (Singh *et al.,* 2019a). Finally, the date of last cut on 15th March gave the tallest plants at harvesting compared with the other dates of last cut.

Adding 15 kg N fad.$^{-1}$ + foliar spray of micronutrients to clover increased seed yield,this may be due to the role of micronutrients in improving seed filling which due to photosynthetic activity and effective translocation of assimilates to reproductive parts and involved in enzymatic reduction of nitrates to ammonia, helps in conversion of inorganic phosphates to organic form, improves nodule formation and fixation of nitrogen and assists protein formation may ultimately improve the resulting seed yield.(Dhaliwal *et al*., 2008; Singh *et al*., 2019b) found that N fertilizer with micronutrients are essential for plant growth and play vital role in balanced crop nutrition. However, plants don't require as much of micronutrients but they are important to plant nutrition as primary and secondary macronutrients.

These results indicated that time of last cut for forage one of the important factors that effect on seed quality due to its effect on developing seed production technology. However, very short time is left seed setting if the last cutting is delayed resulting in weak seed setting and poor seed quality. The results obtained are in partial agreement with those reported by (Gondal *et al.,* 2021) who stated that the optimum production of seed quality with the last cutting taken between 10th and 20th March. Also, (Yadav *et al*., 2015) demonstrated that seed quality measured in terms of germination and vigor decreased with delay in date of last cut. On contrast, (Sardana and Narwal, 2000) reported that cutting management didn't show much effect on the quality of harvested seed.

Also, results proved the importance of adding nitrogen fertilization to the soil because it contributed to increasing nitrogen fixation by root nodal bacteria and also improved the soil properties and plant ability to absorb mineral salts, thus improving metabolism operation in the plants. Also, foliar spray of micronutrients is considered an active method and leads to increased absorption of many nutrients, in addition to enhancing the nutrient use efficiency and promoting crop growth by maintaining the optimum nutrient level in the root zone of plants. All the above lead to increasing the seed yield and quality. These results are in concurrence with those reported by (Kumar *et al.,* 2013; Rani *et al.,* 2017; and Walaa *et al.,* 2021).

Regarding to the interactions between the dates of the last cut and fertilizer systems results revealed that all dates of last cut for forage without adding fertilizer gave the lowest values of seed yield, yield components and seed quality parameters. Meanwhile, the dates of last cut for forage on 15th April and 15th March appeared to recorded higher values of most characters under study when was added nitrogen fertilizer only or nitrogen fertilizer with foliar spray of micronutrients.Whereas, availability of pollinators and congenial climatic conditions for these dates of the cut material has helped in attaining maximum seed yield.The same trend was shown from the results of (Usmani *et al.,* 2001).

The last cut of forage up to the 15th of April with the application of the most appropriate fertilizer system provides sufficient time to have three cuts for forage when the Egyptian clover crop was sown during the first week of November. This means that the date of last cut for forage until April 15th can provide a balanced feed and a high quality of seed yield.

CONCLUSION

To harness the maximum benefits of the dual-purpose Egyptian clover crop, it is suggested that the optimum time of the last cut be on April 15th. where, in such a way that blooming and seed development stages coincide with the favourable weather conditions. However, if you start with 15 kgN fad^{-1} as a starter and spray your plants with micronutrients, you could increase forge yield, increase the number of seeds and improve the quality and quantity of seeds.Furthermore, the time of last cut on April 15 is indicated as the optimal time to last cut with applying 15 kg N fad^{-1} foliar spray of micronutrient for enhanced seed production and good quality with enough quantity of forage yield and the improvement of maximum income per unit area with Egyptian clover for the dual purpose.

REFERENCES

Ali, S., Khan, A. R., Mairaj, G., Arif, M., Fida, M., and Bibi, S. (2008). Assessment of different crop nutrient management practices for yield improvement. *Australian Journal of Crop Science*, *2*(3), 150-157.

Amal A.Helmy, Abo El-Soud , A. A., Desoky, A. H.& Magda N. Rajab (2014). The negative impacts of mineral nitrogen fertilizer on inoculated Berseem clover with rhizobia. *Egypt Journal of Applied Science,* 29 (5), 317-335.

Amato, G., Giambalvo, D., and Ruisi, P. (2013). Cut and Post-Cut Herbage Management Affects Berseem Clover Seed Yield. *Agronomy Journal*, *105*(4), 1222-1230.

AOAC (1990). Association of Official Methods of Analysis Chemists. Official Methods of Ed. Washington D.C. USA.

AOAC (2000). Official Methods of Analysis, of the Association of Official Analytical Agricultural Chemists, 17th ed. Published by A.O.A.C.

Aosa, I. (1983). Seed vigor testing handbook. *Association of Official Seed Analysts. Contribution*, *32*, 88.

Arora, S., and Chahal, D. S. (2007). Soil boron extraction in relation to its availability for clover grown on semi-arid soils of Punjab. *Agrochimica*, *51*(1), 76-85.

Bhuker, A., Singh, N.,Malik, A.,Mor, V. S.& Bishnoi, D. (2019). Effect of pinching and foliar sprays on seed yield and quality of Dhaincha (*Sesbania aculeate*). *Agronomy New Zealand* 49, 17-23.

Black, C. A., Evans, D. D., and Ensminger, L. E. (1965). Methods of soil analysis. Agronomy, 9 Amer. Soc. Agron. *Inc. Publisher, Madison, Wisconsin. USA*.

Copeland, L.O. (1976). Principles of Seed Science and Technology. *Burgess Pub. Com., Minneapolis, Minnesota.U.S .APp:* 164-165.

Cottenie, A., Verloo, M., Kickens, L.,Velghe, G.&Camerynch R. (1982). Chemical Analysis of Plants and Soils. Laboratory of analytical and AgrochemistryState University Ghent, Belgium.

Dhaliwal, S. S., Manchanda, J. S., and Tiwana, U. S. (2009). Seed Production of Egyptian Clover [*Trifolium alexandrium* (L.)] as Influenced by Foliar Application of Zn, Mn, Mo and B on Loamy Sand Soil. *An Asian Journal of Soil Science*, *3*(2), 257-260.

Economic Reports (2020). " Field Crops Statistical year Book." Ministry of Agriculture and Land Reclamation, Egypt.

Economic Reports (2021). " Field Crops Statistical year Book." Ministry of Agriculture and Land Reclamation, Egypt.

El-Zanaty, I. A. (2005). Influence of sowing date on forage and seed yield on some new varieties of Egyptian clover. *Minia Journal of Agriculture Research and Development*, *25*, 757-780.

FAOSTAT (2021).Statistical databases.Food and Agriculture Organization of the United Nations.http://www.fao.org/faostat/en/#data/QC.

Gondal, M. R., Rizvi, S. A., Hanif, M. S., Mahmood, T., Naseem, W., Hayat, S., ... and Khan, A. Developing the quality seed production technology for berseem (*Trifolium alexandrinum* L.) fodder *International Journal of Agriculture Technology,* 17(2),479-496.

Gul, H., Saeed, B., Said, A., Mohammad, F.&Ahmad, I.(2011). Influence of late planting dates and planting methods on seed production of clovers. *ARPN Journal of Agriculture and Biological Science,*6, 1-5.

ISTA (1985). International Seed Testing Association. International Rules for Seed testing Proc. Int. Seed Test. Assoc., 31, 1-52.

ISTA (1999). International Rules for Seed Testing, Seed Science and Technology. *Proc. Int. Seed Test. Ass.* 31 (1),1-152.

Kanwaljit, S. &Tarandeep, A. (2019). Effect of time of sowing and last cut on green fodder and seed production in Berseem (*Trifolium alexandrinum* L.) *J Pharmacogn and Phytochem, 8(1S),234-237*

Karjule, A., and Shelar, V. (2021). Effect of Sowing Dates, Cutting Regimes and Nutritional Sprays at Reproductive Stage on Seed Yield and Quality of Berseem (*Trifolium alexandrinum* L.). *Research Biotica*, *3*(1), 19-24.

Krishnasamy, V., and Seshu, D. V. (1990). Germination after accelerated ageing and associated characters in rice varieties. *Seed Science and Technology (Switzerland)*, *18*(1), 147-156.

Kumar, B., Ram, H., and Sarlach, R. S. (2013). Enhancing seed yield and quality of Egyptian clover (*Trifolium alexandrinum* L.) with foliar application of bio-regulators. *Field Crops Research*, *146*, 25-30.

Mohamed, A. A., Bakheit, B. R., Teama, E. A., and Fathy, F. M. (2017). Effect of planting date, variety and their interaction on seed yield and its components of Egyptian clover (*Trifolium alexandrinum* L.). *Assiut Journal of Agricultural Science*, *48*, 1-11.

MSTAT, V. 4, (1986). A micro computer program for the Design and Analysis of Agronomic Research Experiments. Michigan State Univ., USA.

Oushy, H. (2008). Fact sheet: Berseem clover. Afghanistan Water, Agriculture, and Technology Transfer (AWATT) Program,*College of Agricultural, Consumer, and Environmental Sciences,* New Mexico State University, USA.

Pasumarty, S. V., Matsumura, T., Higuchi, S., and Yamada, T. (1993). Causes of low seed set in white clover (Trifolium repens L.). *Grass and forage science*, *48*(1), 79-83.

Rani M., Singh, S.,Tiwana, U. S., Sarlach, R. S.& Goyal, M. (2017). Effect of plant growth regulators on yield and quality of berseem (*Trifolium alxandrinum* L.) seed. *Forage Research,*42(4),243-247.

Sardana, V., And Narwal, S. S. (2000). Influence of time of sowing and last cut for fodder on the fodder and seed yields of Egyptian clover. *The Journal of Agricultural Science*, *134*(3), 285-291.

Singh, V. (1993). Berseem (*Trifolium alexandrinum* L)-a Potential Forage Crop. *Outlook on Agriculture*, *22*(1), 49-51.

Singh, A., Sharma, R., and Singh, A. (2019a). Effect of date of sowing and cutting management on seed yield in berseem (*Trifolium alexandrinum* L.). *Journal of Krishi Vigyan*, *8*(1), 96-100.

Singh, C., Singh, B., Satpal, A., Kumar, P., Ankush, A.,Gora, M. K.&A. kumar, A. (2019b).Micronutrient management for enhancing production of major fodder crops - a review. *Forage Research,*45(2), 95-102.

Snedecor, G.W. & Cochran, W. G. (1989). "*Statistical Methods*". 7th ed., Iowa State Univ. Press, Ames, Iowa, USA, 255-269.

Steel, R. G. D. (1997). Analysis of variance II: multiway classifications. *Principles and procedures of statistics: A biometrical approach*, 204-252.

Umran, H., Canan, O., Sermin, C., Ali, O., and F Serap, E. (2012). Major-minor element analysis in some plant seeds consumed as feed in Turkey. *Natural Science*, *2012*.

Usmani Khail, M. U., Hameed Ansari, A., Rajput, L. S., Oad, F. C., Oad, N. L., and Sohu, G. N. (2001). Effect of Agronomic Practices on Fresh Forage and Seed Yield of Barseem *Trifolium alexandrium* L. *Journal of Applied Sciences*, *1*(3), 359-362.

Virender, S., and Narwal, S. S. (2000). Seed yield and quality of late-sown berseem (*Trifolium alexandrinum*) under different sowing dates and cutting management. *Indian Journal of Agronomy*, *45*(2), 437-442.

Walaa, M. E. Mousa, Magda N. Rajab &Amany M. Sallam (2021). Influence of foliar application of bio-regulators on yield and quality of Egyptian clover seed. *Journal of American Science,*17(4),9:18.

Yadav, P. S., Vijay, D., and Malaviya, D. R. (2015). Effect of cutting management on seed yield and quality attributes of tetraploid berseem. *Range Management and Agroforestry*, *36*(1), 47-51.

Zahid, A., Haider, K., Shah, S. A., & Iftikhar, A. (2010). Evaluation of leguminous forage crops for nodulation, nitrogen fixation and quality yield. *American-Eurasian Journal of Agricultural and Environmental Science*, *9*(3), 269-272.

Zizy M. Abbas, & Awad, A. M. (2018). Effect of Potassium Foliar Applications on Productivity and Quality of Mono-Cut Egyptian Clover under Saline Soil. *Egyptian Journal of Agronomy*, *40*(2), 155-163.

تأثير ميعاد الحشة الأخيرة ونظم التسميد على محصول العلف وإنتاج البذور وجودتها في البرسيم المصري

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تم إجراء هذا البحث بمحطة بحوث الزراعية بكفر الحمام – التابعة لمركز البحوث الزراعية بمحافظة الشرقية– مركز البحوث الزراعية (ARC) وتجربتان معمليتان في قسم بحوث محاصيل العلف وقسم بحوث تكنولوجيا البذور خلال الموسمين الشتويين لعامين متتاليين 2019/2018 2020/2019. لدراسة تأثيرثلاثة مواعيد للحشة الأخيرة (15 مارس و 15 أبريل و 15 مايو) وثلاثةنظم للتسميد (بدون تسميد ، 15 كجم ن/ فدانو 15 كجم ن/ فدان + رش ورقي بالعناصر الصغرى) على محصول العلف وحاصل البذور ومكوناته وجودة البذور والتقييم الاقتصادي للبرسيم المصري (الصنف الهلالي)، تم استخدام تصميم القطاعات الكاملة العشوائية للقطع المنشقة مرة واحدة في ثلاث مكررات لكل موسم. ويمكن تلخيص نتائج البيانات المجمعة لموسمي الزراعة على النحو التالي:أدى تأخير ميعاد الحشةالأخيرة في 15 مايو إلى زيادة معنوية في محصوليالعلف الموسمي الأخضر والجاف (44,00 و 8,63 طن/ فدان) على التوالي ، مقارنة ب 15 مارس و 15 أبريل. بينما أعطى ميعاد الحشةالأخيرةفي 15 أبريل أعلى قيم لمحصول البذور ومكوناته بالإضافة إلى تحسين معظم صفات جودة للبذور.تفوقتالمعاملة 15 كجم ن/ فدان + الرش الورقي بالعناصر الصغرى مقارنة بكلا من الكنترل وعند إضافة 15 كجم ن/ فدان. حيث أدى تطبيق المعاملة15 كجم ن/ فدان+ الرش الورقي للعناصر الصغرى إلى زيادة محصولي العلف الموسمي الأخضر والجاف بنسبة 25,06 و28,70٪ ، وإنتاج البذور بنسبة 21,31٪ ، والإنباتبنسبة6,89٪ ، ومؤشر قوة البذور بنسبة 7,04٪. ومؤشر قوة البادرات بنسبة 58,38٪ مقارنة بالكنترول.كان للتفاعل بينميعاد آخر حشة ونظام التسميد تأثير معنوي على معظم صفات البرسيم المصري المدروسة، حيث تم الحصول على أعلى محصولي علف موسمي أخضر وجاف (47,40 و 9,29 طن/ فدان) في 15 مايو مع إضافة 15 كجم ن/ فدان + الرش الورقي بالعناصر الصغرى، بينما تم تسجيل أعلى إنتاج للبذور (512,24 كجم/ فدان)وأفضل معايير لجودة البذور مع دخل صافي مقدرا بحوالي 15447,26 جنيهاً مصرياً اعتباراً من 15 أبريل كتاريخ لآخر حشة وباستخدام 15 كجم ن/ فدان + الرش الورقي بالعناصر الصغرى في محصول البرسيم المصري.بناءً على نتائج البحث ، يوصى بأن يكون 15 أبريل هو الوقت الأمثل للحشة الأخيرة مع تطبيقإضافة 15 كجم ن/ فدان + الرش الورقي بالعناصر الصغربلتحسين إنتاج البذور بجودة عالية مع الحصول على كمية كافية من محصول العلف الأخضر بالإضافة إلى تعزيز الحد الأقصى للدخل لكل وحدة مساحة من البرسيم المصري الثنائي الغرض ، خاصة وأن البذور لا يمكن إنتاجها إلا على حساب جزء من محصول العلف.

الكلمات المفتاحية: البرسيم المصرى، ميعاد الحشة الأخيرة، نظام التسميد، محصول العلف، انتاج البذور وجودة البذور.