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Study Application of N- Fertilizer and molasses on Sustaining Soil fertility and Maximized Yield of wheat and N- utilization

Shimaa M. Elmahdy[1], Salah El-Din A. Faizy[1], Rokaia S. Meselhy[2] and **Megahed M. Amer[2*]**

[1]*Soil and Water Dept., Faculty of Agriculture, Kafrelsheikh Univ., Egypt*
[2]*Soils, Water and Environment Research Institute, Agriculture Research Center, Egypt*

DURING the two growing seasons of 2021–2022 and 2022–2023, an experiment (field) was carried out at the faculty of agriculture's farm at Kafrelsheikh Univ., Egypt. This study set out to investigate the application of N fertilizer and molasses to the soil, the effects of this combination on improving specific soil properties, the cost-effectiveness of nitrogen use, the optimization of wheat grain and straw yields and uptake, and the economic assessment of wheat yield. The major plots of the split-plot design were assigned to five distinct nitrogen treatments (N0: without, N40: 40 kg fed^{-1}, N80: 80 kg fed^{-1}, N120: 120 kg fed^{-1}, and N160: 160 kg fed^{-1}) and four molasses treatments (M0: without molasses, M30:30L fed^{-1}, M60: 60L fed^{-1}, and M90:90L fed^{-1}).The findings showed that soil bulk density dropped considerably following two growing seasons when molasses application reached 90 Lfed.$^{-1}$. At the same time, soil porosity hit its peak levels during this treatment, moving in the opposite direction from bulk density. When molasses was applied at rates up to 90 l fed^{-1}, there were notable improvements in soil NPK levels, NPK uptake by plants, protein content, how efficiently nitrogen was used, nitrogen recovery rates, and overall wheat production, with the M90 treatment showing the best results across the board. When nitrogen and molasses treatments were combined, they worked together to significantly boost flag leaf size, the number of spikes per square meter, thousand-grain weight, grain production, straw production, protein levels, and total NPK absorption by the plants. It could be concoluded that yield of wheat responded to the interaction between 160 kg of N/ feddan and 90 L of molasses / feddan, the best results for total profits, net profits, and the ratio of benefits to costs. Also, adding 90 L of molasses / feddan really boosted the levels of N, P, and K that plants could actually use from the soil. Additionally, the most efficient N use when applied about 104 kg of N and 79 L of molasses / feddan. The plants recovered N best with slightly different amounts - around 105 kg of N and 82 L of molasses / feddan .For getting the biggest grain harvest, the sweet spot was using about 148 kg of N and 84 L of molasses / feddan. to maximize straw production instead by 145 kg of N and 78 L of molasses / feddan.

Keywords: molasses, net return, Nitrogen use efficiency (NUE), N-recovery, nutrients uptake, porosity, wheat yield and soil fertility.

1. Introduction

Wheat (*Triticumaestivum-L.*) is one of the main winter cereal crops for grain and straw production.According to the Ministry of Agriculture and Land Reclamation, **Economic Affairs Sector (2024)**, Egypt produces 9.44 million tons of wheat, covering only 44.51 % of its annual demand (21.52 million-ton), leaving a 55.49 % import gap (12.08 million tons). Nitrogen fertilizer is one of the most important mineral fertilizers added to cereal crops to improve growth and yield. The nitrogen fertilization improved grain quality and increased protein content by improving nitrogen uptake, Nitrogen use efficiency and Nitrogen metabolism**(Amer, 2009 and Rossini et al., 2025).El-Refaey et al. (2022)** stated that the addition of 100 kgNfed.$^{-1}$ increased straw yield. The different parameters of yield, N uptake and protein content were significantly increased by increasing N levels up to 120kgNfed.$^{-1}$ **(Amer 2009)**. When it comes to fertilizing wheat, research shows that applying 100 kg of N/feddan gave the best results for wheat yield and its components, according to **El-Refaey et al. (2022).** Another study by **Atia and Ragab(2013)** found that the top grain yields came from using 90 kg of N fed^{-1}.**Shahin (2020)** pointed out that farmers should try to match their nitrogen application as closely as possible to what the plants actually need and what's already available in the soil. The amount of N also affects how much protein ends up in the wheat grains, as **Zhao et al. (2015).** While **Shahin's (2020)** research showed that 90 kg of N/feddan produced the highest yields and N uptake, some treatments actually showed lower N use efficiency. On the other hand, **Faizy's et al. (2010)** showed that wheat yields peaked when they applied 140 kg of N/feddan. A couple

*Corresponding author e-mail: megahedamer3@gmail.com
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years later in 2012, the same research group reported that both grain and straw yields increased significantly when nitrogen levels went up to 120 kg /feddan for the Giza 168 and Sids7 wheat varieties.

Yield component, NPK uptake, N efficiency and N recovery percentage of wheat were significantly increased by adding of molasses **(Ibrahim 2021),** it stimulated plant growth **(Adi et al., 2023),**improved soil aggregation, **(Wynne and Meyer, 2002)**, increased soil hydraulic conductivity**(Gaafar et al 2019)**,increased the vegetative growth, yield and improved soil physical, microbiology and its fertility **(Amer 2015, Pyakurel et al, 2019 and Omara et al., 2022)**.Molasses contains organic carbon, mineral nutrients such as N, P, K, Mg, Ca, S, Fe and some important micronutrients, and the K (%) was higher in the case of plant roots with sugar beet molasses **(Kozminska et al, 2021).**With an increase in molasses up to 175 Lfed.$^{-1}$, soil bulk density was decreased, soil porosity improved, availability of N PK in soil was increased **(Rashedet al., 2022 and Omara et al. 2022),** and soil available potassium was increased**,(Sanli et al., 2015).**Surface application molasses (150Lfed^{-1}), increased yield of sugar beet and sugar content, improved the available NPK and organic matter and calcium contents in the soil **(Abofard et al., 2021 and Rashed et al. 2022)**. Applied of 200 Lfed^{-1} of molasses, to the soil enhanced the physicochemical properties of the soil **(El-Tokhy et al. 2019 and Rashed et al.2022).**The highest yield of sugar beet was recorded with 60Lfed^{-1} of sugar beet molasses **(Abd El-Azeem, 2023)**, Nevertheless, molasses application or overuse can cause salts and other harmful materials to build up in the soil, which can ultimately reduce soil production **(Naveed et al., 2018).** Integrated fertilization can improve soil properties and conditionsand the right combination of fertilizers and cropping systems is still an open question that needs to be answered, **(El-Bialy et al, 2025).**The co- application of mineral and organic fertilizers can also improve utilization of N- fertilizer **(Wu et al., 2020).**The present study hypothesizes that due to the high calcium and organic acid content of molasses, it can effectively improve the physicochemical properties of soil and thus maximize both of wheat productivity and utilization of nitrogen fertilizers.This study aimed to evaluate the following: soil application of N-fertilizer, molasses and the interaction effects between them on improving some soil properties; maximizing grain, straw yields of wheat, uptake and N- use efficiency and economic evaluation yield of wheat

2. Materials and Methods

2.1. Experimental design

A field study took place at the Faculty of Agriculture farm at Kafr El-Sheikh Univ., during two growing seasons from 2021/22 to 2022/23 to studieds of different amounts of N and sugar beet molasses affected wheat yields, how well plants absorbed certain nutrients, and whether various treatments made economic sense for wheat farming. They set up the experiment using a split-plot design with three repetitions to make sure their results were reliable.The subplots were exposed to the four levels of sugar beet molasse (0, 30, 60, and 90 L fed^{-1}) whereas the main plots were assigned to nitrogen levels of 0, 40, 80, 120, and 160 kgNfed^{-1}. Each plot had three by three and a half meters (1/400 fed) and was seeded with wheat (*Triticum aestivum* L.). In 2021 and 2022, Sakha 94 were sown on November 15 and November 13, respectively, and harvested on May 9 and May 12, 2023. The nitrogen was added as urea (46% N).Before planting, soil tillage was used to apply 50 kg of K fertilizer as K_2SO_4 (48% K_2O) and P fertilizer 50 kg fed.$^{-1}$ as (15% P_2O_5).

2.2. Soil characteristics and analysis

Before planting and after harvesting in both seasons, soil samples were collected from three levels of each plot (0–20, 20–40, and 40–60 cm). As indicated in Table (1), the physical and chemical characteristics of the soil were assessed in accordance with **Klute (1986**) and **Page et al. (1982**).

2.3. Plant analysis

According to **Owen (1968),** plant samples were randomly selected from each plot 90 days following sowing in order to calculate the flag leaf area.In order to calculate the 1000-grain weight (g), twenty spikes were randomly selected from each plot and one square meter of plants were gathered at harvest. Following the harvest of each plot's plants, the yields of grain and straw in kilograms fed each day were calculated. **Yash (1998)** explained that they gathered plant samples when the crops were ready for harvest each season. They washed the samples with distilled water, then dried them in an oven at 70°C for two days straight. After that, they ground up the dried samples and mixed them together. To break down the plant material, they used hot sulfuric acid and kept adding 30% hydrogen peroxide (H_2O_2) bit by bit. When they wanted to figure out how much protein was in the samples, according to**A.O.A.C. (1980).** For every treatment, the apparent nitrogen recovery of fertilizer (%) was determined using the following formula **(Crasswell and Godwin, 1984):**

$$\textbf{Recovery of N fertilizer (\%)} = \frac{\text{N-uptake from fertilized-N-uptake from control}}{\text{N-applied from fertilizer}} \times 100$$

$$\textbf{N-use efficiency:(Kggrains/Kg N)=} \frac{\text{Grain from treatment -grain from control}}{\text{fertilizer N-application}}$$

2.4. Economic evaluation (profitability)

FAO (2000) provided the following formulas for calculating profitability: Benfit Cost Ratio, BCR (= net return / total cost), Net return, NR (= total return-total cost), and Total return (= yield X price LE, grain+straw).

Table 1. Average values of some physicochemical properties of the experimental soil during the two growing seasons (2022 and 2023).

Depth (cm)	Physical properties							
	Soil moisture				PSD(%)			
	FC (%)	WP (%)	AW (%)	BD (kg m^{-3})	Sand	Silt	Clay	Soil texture
0-20	44.11	22.18	21.93	1.35	17.30	25.50	57.20	clay
20-40	40.52	20.29	20.23	1.36	18.83	24.78	56.39	clay
40-60	38.03	19.13	19.90	1.36	19.03	25.15	55.82	clay

Depth (cm)	Chemical properties								
	pH*	EC** dSm^{-1}	SAR	CEC $cmolekg^{-1}$	OM	$CaCO_3$	Ava.N (%)	Ava. P	Ava. K
0-20	8.01	3.65	8.5	37.36	1.71	2.42	16.5	6.5	241
20-40	8.04	3.68	8.8	36.45	1.60	2.53	16.1	6.1	230
40-60	8.04	3.71	9.2	35.42	1.32	2.31	15.4	6.0	225

PSD: Particle size distribution; FC: Field Capacity; WP: Wilting Point; AW: Available Water; BD: Bulk Density; pH*: was determined in soil water suspension (1:2.5); EC**: was determined in saturated soil paste extract; SAR: Sodium adsorption ratio; CEC: Cation Exchange Capacity;OM: Organic Matter.

Table 2. Analysis of sugar beet molasses.

Item	%	Item	%	N.O.A[(1)]	%	vitamins	Value, mg kg^{-1}
NO_3	0.40	Sucrose	48	lactic	1.30	pyridoxine (B6)	0.5
PO_4	0.21	Water	20	citric,	0.75	thiamine (B1)	1.3
K^+	5.0	Starch	1.0	malic	0.75	riboflavin (B2)	0.4
Ca^{2+}	1.5	Polysaccharides	1.0	oxalic,	0.20		
Mg^{2+}	1.14	Dextrin	3.0	succinic	0.20	Density (gcm-2)	1.47
Na^+	0.17	Total N content	10	acetic	0.20	O.M(non sugars)	21.90
Cl^{2-}	0.4	Crude protein	9.5	propinic	0.20		
SO_4	1.12	Glutamic acid	2.5	putyric	0.20		

[(1)]: Non-nitrogenous organic acids

2.5. Statistical Analyses

The statistical analysis was conducted using DMRT (Duncan's Multiple Range Test) and CoStat (Version 6.303, CoHort, USA, 1998-2004), as outlined by **Gomez and Gomez (1984).**

3. Results

3.1. Bulk density andsoilporosity

According to Table 3, nitrogen fertilization didn't really make much difference to the soil's bulk density during either growing season. However, the data revealed that adding molasses had a notable impact - it actually

reduced the soil bulk density quite a bit during both seasons. The best results came when they used 90 L of molasses /feddan, which gave them the lowest density readings at 1.363 and 1.362 kg / cubic meter for the first and second seasons. When they looked at how N and molasses worked together, there wasn't any significant interaction effect on bulk density during either season. On the flip side, soil porosity got a real boost from the molasses treatment, reaching its highest levels of 48.55 and 48.60% in the first and second seasons when they applied that same 90 L/feddan of molasses, as shown in Table 3.

Table 3. Soil bulk density(kgm^{-3}) and soil porosity (%) as affected by application N-fertilization and molasses application after harvesting of wheat in the two growing seasons (2021/2022 and 2022/2023).

Treatments	2021/22		2022/23	
	Bd(kgm^{-3})	Porosity(%)	Bd(kgm^{-3})	Porosity(%)
Nitrogen fertilization (kgfed.$^{-1}$)				
0	1.367a	48.38a	1.366a	48.41a
40	1.367a	48.38a	1.366a	48.41a
80	1.367a	48.38a	1.366a	48.41a
120	1.367a	48.38a	1.366a	48.41a
160	1.367a	48.38a	1.366a	48.41a
F_{test}	ns	ns	ns	ns
Molasses(Lfed.$^{-1}$)				
0	1.377a	48.08d	1.376a	48.08d
30	1.366b	48.42c	1.365b	48.49c
60	1.365c	48.47b	1.364c	48.50b
90	1.363d	48.55a	1.362d	48.60a
F_{test}	**	**	**	**
$LSD_{0.05}$	0.002	0.009	0.002	0.008
$LSD_{0.01}$	0.003	0.013	0.0021	0.011
Interaction (N x M)				
N*M	ns	ns	ns	ns

3.2. Availablity of nitrogen, Phosphorus and Potassium in soil

Table (4) demonstrated that increasing nitrogen fertilization greatly enhanced the amount of nitrogen available (mgkg^{-1}). The highest values (25.2 and 26.21 mgkg^{-1}) were obtained for the first and second seasons, respectively, when N fertilization was increased to 160 kgfed^{-1}. Additionally, the same data demonstrated that the mean nitrogen availability values improved significantly as molasses was increased. The greatest values (27.62 and 30.44 mgkg^{-1}) were observed for the first and second seasons, respectively, when molasses application was raised up to 90 Lfed^{-1}.The findings demonstrated that increasing nitrogen fertilization greatly boosted phosphorus availability, with the first and second seasons recording the greatest values (8.49 and 8.46 mgkg^{-1}) when N fertilization was increased to 160 kgfed^{-1}. Additionally, the same data (Table 4) demonstratedthat the mean values of phosphorus availability improved significantly as molasses was increased. For both seasons, the maximum values (9.62 mgkg^{-1}) were obtained by increasing molasses application up to 90 L fed^{-1}.

The same data also showed that increasing nitrogen fertilization greatly boosted potassium availability, with the maximum values (271.0 and 274.3 mgkg^{-1}) occurring in the first and second seasons, respectively, when N fertilization was increased to 160 kgfed^{-1}. Additionally, the same data demonstrated that the mean potassium availability values increased significantly as molasses was increased. The greatest values (286 and 289 mgkg^{-1}) were observed for the first and second seasons, respectively, when molasses application was raised up to 90 Lfed^{-1} (Table 4).As seen in Table 4, the interaction between nitrogen (N) and molasses (M) during the two growth seasons greatly boosted the availability of NPK .

Table 4. Availability NPK ($mgkg^{-1}$) in soil as affected by N- fertilization and molasses application for two growing seasons (2021/2022 and 2022/2023).

Treatments		2021/22			2022/23		
Nitrogen ($kgfed^{-1}$)	Molasses ($Lfed^{-1}$)	N	P	K	N	P	K
0	0	15.0o	14.56^{o}	6.68jk	6.73ij	226.73n	277.66n
	30	18.2k	19.1l	6.78 ij	6.80ij	246.5j	246.33k
	60	18.7j	21.93j	6.88ij	6.90i	258.00gh	257.66i
	90	18.9j	25.90f	8.75e	8.80e	275.00d	278.33e
40	0	15.16^{no}	14.70^{o}	6.41l	6.48^{k}	230.6^{m}	235.00^{m}
	30	18.86j	20.83k	7.78fg	7.83fg	249.33i	250.33j
	60	19.10j	22.63i	8.58e	8.63e	260.00g	264.00h
	90	25.86e	27.93d	9.51 cd	9.60c	280.00c	284.00d
80	0	15.53mn	15.36n	6.95i	6.89i	233.66l	235.60m
	30	20.53i	24.00h	7.98f	8.00f	257.66h	258.33i
	60	22.13h	26.90e	8.61e	8.66e	266.66f	268.33g
	90	28.73c	30.93c	9.60bc	9.66bc	287.66b	287.33c
120	0	15.76m	15.50n	6.81ij	6.90i	236.33k	238.33l
	30	23.73g	24.83g	7.21h	7.23h	265.00f	267.66g
	60	25.60e	27.36e	8.58e	8.63e	270.33e	276.33ef
	90	31.63b	32.40b	9.82b	9.87b	289.66b	295.00b
160	0	16.06l	16.00m	6.51kl	6.58jk	236.33k	239.33l
	30	24.63f	25.50f	7.71g	7.76g	271.33e	274.66f
	60	27.13d	28.30d	9.31d	9.34d	278.33c	283.00d
	90	33.00a	35.06a	10.41bc	10.16a	298.00a	300.33a
N	F_{test}	**	**	**	**	**	**
	$LSD_{0.05}$	0.36	0.49	0.24	0.22	2.01	1.37
	$LSD_{0.01}$	0.49	0.66	0.32	0.30	2.70	2.33
M	F_{test}	**	**	**	**	**	**
	$LSD_{0.05}$	0.22	0.25	1.17	0.26	0.22	1.18
	$LSD_{0.01}$	0.32	0.37	1.07	0.38	0.32	1.72
Interaction (N x M)	F_{test}	**	**	**	**	**	**
	$LSD_{0.05}$	0.16	0.103	0.89	0.22	0.101	0.77
	$LSD_{0.01}$	0.22	0.138	1.21	0.29	0.136	1.04

According to the Duncan's test, means denoted by distinct letters signify significant differences across treatments ($p < 0.01$).

3.3. Yield of wheat and growth

3.3.1. Growth

The results in Table 5 showed that wheat flag leaf area grew substantially when more nitrogen fertilizer was applied, hitting peak measurements of 43.63 and 45.19 cm^2 when nitrogen levels reached 160 kg /feddan in both growing seasons. The data also revealed that adding more molasses led to noticeable increases in wheat flag leaf area, with the best results of 40.75 and 41.19 cm^2 occurring when molasses application reached 90 L /feddan during each respective season. Similarly, the number of wheat spikes per square meter increased significantly with higher nitrogen fertilizer rates, achieving maximum counts of 292 and 296 spikes when nitrogen application hit 160 kg /feddan in the first and second seasons.

The same information also showed that when more molasses was added, the number of wheat spikes in each square meter went up significantly. The highest numbers, 280.5 and 286 spikes / square meter, happened during the first and second growing seasons when farmers used 90 L of molasses /feddan. When wheat plants got more nitrogen fertilizer, their 1000-grain weight went up quite a bit too, reaching peak weights of 40.75 and 41.77 grams in the first and second seasons when nitrogen was bumped up to 160 Kg/feddan. The data also showed that wheat's 1000-grain weight got heavier when molasses amounts were increased. The heaviest weights, 39.77 and 41.19 grams, were seen in the first and second seasons when molasses was raised to 90 L/feddan. Looking at Table 5, you can see that when nitrogen and molasses were used together over both growing seasons, there was a really significant boost in flag leaf area, the number of spikes per square meter, and 1000-grain weight.

Table 5. Flag leaf, no.of spikesm^{-2} and 1000-grain weight of wheat as affected by N- fertilization, molasses application and the interaction between N*M for two growing seasons (2021/22 and 2022/23).

Treatments	Flag leaf (cm^2)		No. of spikes m^{-2}		1000-grain weight (g.)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Nitrogen fertilization (kgfed.$^{-1}$)						
0	35.61e	35.65e	177.08e	181.50e	37.34e	38.21e
40	38.35d	38.36d	246.50d	253.16d	37.99d	38.81d
80	40.58c	40.57c	276.50c	281.50c	39.89c	40.91c
120	41.97b	42.20b	286.50b	294.60b	40.54b	41.66b
160	43.63a	45.19a	292.50a	296.50a	40.75a	41.77a
F_{test}	**	**	**	**	**	**
$LSD_{0.05}$	0.223	0.271	1.121	1.233	2.471	2.800
$LSD_{0.01}$	0.325	0.394	1.447	1.794	3.596	4.077
Molasses (Lfed.$^{-1}$)						
0	39.34d	39.57d	195.20d	201.26d	38.66d	38.96d
30	39.75c	40.12c	271.26c	275.80c	39.26c	40.18c
60	40.27b	40.76b	276.26b	282.60	39.52b	40.77b
90	40.75a	41.19a	280.53a	286.06a	39.77a	41.19a
F_{test}	**	**	**	**	**	**
$LSD_{0.05}$	0.081	0.117	0.994	1.288	0.045	0.042
$LSD_{0.01}$	0.109	0.158	1.509	1.734	0.060	0.057
Interaction (N x M)						
N*M	**	**	**	**	**	**

According to the Duncan's test, means denoted by distinct letters signify significant differences across treatments ($p < 0.01$).

3.3.2. Grain, straw yield of wheat and protein content

The best yields of 2715 and 2963 kg /feddan were achieved when nitrogen fertilizer was applied at 160 kg per feddan during the first and second growing seasons. Figure 1.a clearly shows that wheat grain production increased substantially as more N fertilizer was used. When molasses was added to the treatment, wheat yields also improved significantly, with the highest production levels of 1850 and 2022 kg /feddan recorded in the first and second seasons when 90 L of molasses /feddan were applied, as shown in Figure 1b.

The results in Table 6 clearly showed that when nitrogen and molasses were used together, they had a really strong impact on how much wheat grain was produced in both growing seasons. When researchers combined N160 with M90, they got the best results - 3120 kg /feddan in the first season and 3463 kg /feddan in the second season.Looking at wheat straw production, the numbers were pretty impressive too. Figure 2a shows that as farmers added more nitrogen fertilizer, the straw yield kept going up, reaching peak values of 2876 kg /feddan in the first season and 3177 kg /feddan in the second season. Similarly, when molasses application was increased to 90 liters per feddan, the straw yields hit their highest points at 2010 kg /feddan and 2181 kg /feddan for the first and second seasons respectively, as you can see in Figure 2b. Basically, more molasses meant better straw yields across the board. Just like with grain production, Table 6 confirmed that combining nitrogen fertilization with molasses application made a huge difference in straw yields during both growing seasons. The winning combination of N160 and M90 delivered the top straw yields of 3114 kg /feddan in the first season and 3644 kg /feddan in the second season.

Table 7, showed that when added more nitrogen fertilizer, the protein content in wheat grains went up quite a bit. The best results were obtained by application of 160 kg / feddan - that gave them protein levels of about 11.12 % in the first year and 11.05% in the second year.Table 7 shows something similar happened with molasses. The sweet spot was around 90 L/ feddan, which boosted protein levels to about 10.26 % and 10.27% in the first and second growing seasons.What's really interesting is what happened when they combined both treatments. When

used both 160 kg of N fertilizer and 90 L of molasses together, they got the absolute best results - protein content reached 11.31% in the first season and 11.34% in the second season. This shows that using nitrogen and molasses together works much better than using either one alone.

Fig.1a showed that application of 148.4 and 148.2 kgNfed^{-1} which give maximum grain (2704 and 2950 kg fed.$^{-1}$ for the 1st and 2nd seasons, respectively).While application of 83.3 and 85.3 L molasses fed^{-1} give the maximum grain (1838 and 2006 kg fed^{-1} for the 1st and 2nd seasons, respectively), as shown in Fig.1b. Also, Fig.1c showed that application of 141.28 and 149.20 kgN fed^{-1} give the maximum straw (2942 and 3155 kgfed^{-1} for the 1st and 2nd seasons, respectively).While application of 75.81 and 79.26 L molasses fed^{-1} give the maximum straw(2014 and 2173 kgfed.$^{-1}$ for the 1st and 2nd seasons, respectively). , as shown in Fig.1d.

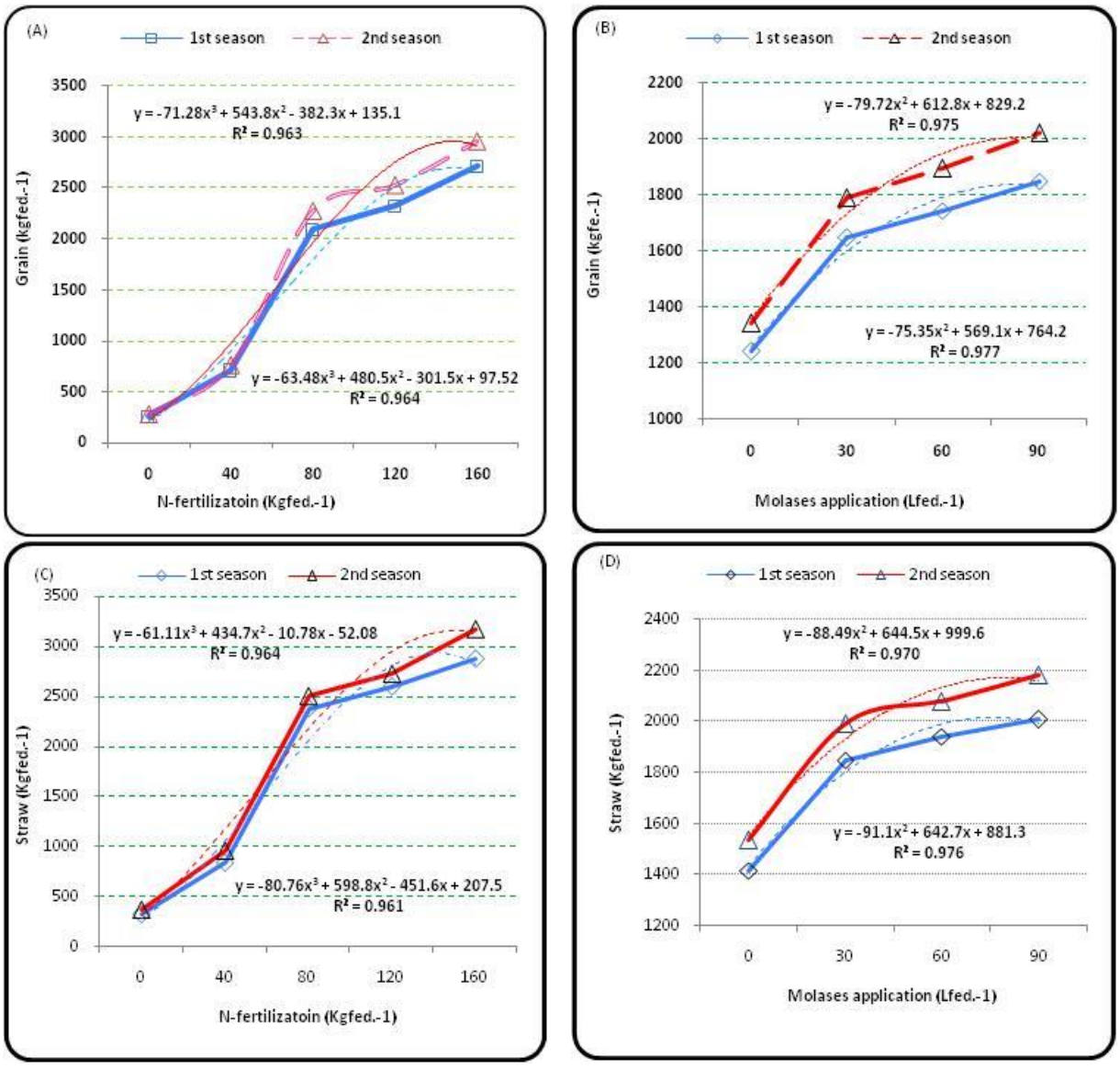

Fig. 1. Grain (A and B) and Straw yield of wheat (C and D) as affected by N-fertilization and molasses application for the two growing seasons 2021/22 and 2022/23.

Table 6. Grain and straw yield of wheat (kg fed^{-1}) as affected by N Fertilization and molasses application for the two growing seasons, (2021/2022 and 2022/2023).

Treatments		2021/22		2022/23	
Nitrogen (kgfed$^{-1)}$	Molasses (Lfed$^{-1)}$	Grain	Straw	Grain	Straw
0	0	241.36q	312.00q	255.06s	347.33q
	30	249.86pq	323.33pq	271.06r	351.66q
	60	275.00op	333.00p	294.50q	380.66p
	90	279.03o	340.60p	294.90q	382.00p
40	0	618.50n	750.00o	655.03p	855.33o
	30	714.63m	816.00n	758.86o	942.66n
	60	754.53l	871.00m	799.66n	996.33m
	90	774.86l	923.30l	835.63m	1036.66l
80	0	1493.4k	1752.00k	1621.33l	1820.00k
	30	2221.16h	2451.30h	2426.33i	2715.00h
	60	2322.9g	2655.00g	2527.50h	2742.00g
	90	2335.2fg	2665.60fg	2540.20g	2747.00g
120	0	1719.46j	1955.00j	1879.70k	2145.00j
	30	2361.23f	2679.60f	2553.80f	2762.66f
	60	2471.00e	2755.00e	2717.13e	2918.33e
	90	2742.83c	3008.30c	2979.60c	3096.00d
160	0	2139.23i	2316.60i	2310.43j	2516.00i
	30	2691.96d	2979.60d	2939.43d	3188.00c
	60	2909.63b	3096.30b	3141.90b	3362.00b
	90	3120.96a	3114.60a	3463.90a	3644.33a
N	F_{test}	**	**	**	**
	$LSD_{0.05}$	13.97	8.63	5.08	3.00
	$LSD_{0.01}$	20.33	12.55	7.40	5.07
M	F_{test}	**	**	**	**
	$LSD_{0.05}$	8.97	5.98	2.69	3.48
	$LSD_{0.01}$	12.08	8.04	3.62	4.04
Interaction (N x M)	F_{test}	**	**	**	**
	$LSD_{0.05}$	20.75	13.37	6.01	6.71
	$LSD_{0.01}$	27.03	18.00	8.10	9.04

According to the Duncan's test, means denoted by distinct letters signify significant differences across treatments ($p < 0.01$).

Table 7. Mean values of protein wheat grain yield (%) as affected by N-fertilization, molasses application and the interaction between Nitrogen and molasses during the two growing seasons (2021/2022 and 2022/2023)

Treatments		2021/2022	2022/2023
Nitrogen(kgfed^{-1})	Molasses (Lfed^{-1})		
0	0	7.45m	7.40m
	30	7.54lm	7.49l
	60	7.63l	7.49l
	90	7.63l	7.58k
40	0	9.90k	9.99j
	30	10.14j	10.14i
	60	10.39i	10.45h
	90	10.58h	10.57g
80	0	9.89k	9.92j
	30	10.44i	10.45h
	60	10.60h	10.60g
	90	10.79ef	10.82e
120	0	10.64gh	10.73f
	30	10.73gf	10.73f
	60	10.96cd	11.01cd
	90	11.01bc	11.03c
160	0	10.88de	11.01cd
	30	10.90cd	10.94d
	60	11.10b	11.19b
	90	11.31a	11.34a
N	F_{test}	**	**
	$LSD_{0.05}$	0.047	0.026
	$LSD_{0.01}$	0.068	0.038
M	F_{test}	**	**
	$LSD_{0.05}$	0.038	0.027
	$LSD_{0.01}$	0.051	0.036
Interaction (N x M)	F_{test}	**	**
	$LSD_{0.05}$	0.085	0.060
	$LSD_{0.01}$	0.114	0.081

According to the Duncan's test, means denoted by distinct letters signify significant differences across treatments ($p < 0.01$).

3.4. Total NPK uptake

The results in Table 8 show that when wheat plants took up more nitrogen, the total yield from both grain and straw went up quite a bit as N fertilizer amounts increased. The best results came from using N160, which gave us 65 and 72 kg /feddan in the first and second growing seasons. We also found that adding more molasses made a real difference in how much N the wheat absorbed, with the top amounts being 44 and 48 kg /feddan when we used 90 L of molasses per feddan in both seasons. What's really interesting is that when we combined N fertilizer with molasses, the N uptake jumped even higher. The combination of N160 with 90 L of molasses gave us the best results at 76 and 86 kg /feddan for the first and second seasons.

The research findings revealed that wheat's total P uptake increased notably as N fertilizer levels rose, with peak values reaching 12.17 and 13.64 kg /feddan in the first and second growing seasons when using N160 treatment. When it came to molasses application, wheat's P uptake also showed significant improvement, hitting maximum levels of 8.28 and 9.24 kg /feddan during the respective seasons when molasses was applied at 90 L/feddan. The most impressive results came from combining both treatments, where N160 paired with M90 produced the highest P uptake values of 14 and 16 kg /feddan across both seasons, as shown in Table 6.

Similar patterns emerged for K uptake in wheat. Higher N fertilization led to significantly better K absorption, with top results of 48.46 and 53.98 kg /feddan achieved using N160 during the first and second seasons. Molasses application also boosted K uptake considerably, reaching peak values of 21.49 and 35.84 kg /feddan when applied at 90 L/feddan in both growing seasons. The data clearly demonstrated that combining N and

molasses treatments had a meaningful effect on wheat's total K absorption throughout both growing periods. The best outcomes occurred when N160 was combined with M90, yielding the highest K uptake rates of 53 and 62 kg /feddan in the first and second seasons.

Table 8. Total NPK- uptake of yield of wheat (kg fed^{-1}) as affected by the interactions between N-fertilization and molasses application during the two growing seasons (2021/2022 and 2022/2023).

Treatments		2021/22			2022/23		
Nitrogen (kg fed^{-1})	**Molasses (L fed^{-1})**	**N**	**P**	**K**	**N**	**P**	**K**
0	**0**	4.17q	0.73r	3.44r	4.44o	0.80q	3.85q
	30	4.37pq	0.78qr	3.59qr	4.69o	0.87pq	3.96q
	60	4.76p	0.85q	3.79q	5.12n	0.96op	4.33p
	90	4.84o	0.92p	3.93p	5.16n	1.02o	4.41p
40	**0**	13.43n	2.24o	8.77o	14.51m	2.48n	10.01o
	30	15.72m	2.78n	10.35n	17.01l	3.09m	11.89n
	60	16.97l	3.02m	12.12m	18.31k	3.34l	13.84m
	90	17.84k	3.29l	13.09l	19.47j	3.67k	14.86l
80	**0**	32.61j	6.17k	26.26k	35.06i	6.79j	27.82k
	30	50.64h	9.55i	37.64i	55.32g	10.67h	41.97i
	60	53.81g	10.02h	41.22g	58.03f	11.04g	43.55h
	90	54.97f	10.52g	42.20f	59.31e	11.60f	44.53g
120	**0**	39.71i	7.62j	30.79j	43.78h	8.56i	34.17j
	30	55.31f	10.67f	42.69e	59.38e	11.68f	44.97f
	60	59.32e	11.13e	44.85d	64.75d	12.41e	48.43e
	90	66.31c	12.63c	49.69c	71.15c	13.81c	52.50d
160	**0**	50.31h	9.54i	38.19h	55.04g	10.58h	41.95i
	30	64.74d	12.04d	49.49c	70.86c	13.45d	53.83c
	60	70.63b	13.05b	52.26b	76.78b	14.44b	57.25b
	90	76.83a	14.07a	53.92a	86.11a	16.10a	62.91a
N	**F_{test}**	**	**	**	**	**	**
	$LSD_{0.05}$	0.154	0.035	0.124	0.113	0.048	0.128
	$LSD_{0.01}$	0.225	0.051	0.181	0.164	0.069	0.187
M	**F_{test}**	**	**	**	**	**	**
	$LSD_{0.05}$	0.146	0.036	0.069	0.107	0.041	0.085
	$LSD_{0.01}$	0.196	0.04	0.09	0.145	0.09	0.114
Interaction (N x M)	**F_{test}**	**	**	**	**	**	**
	$LSD_{0.05}$	0.326	0.081	0.155	0.240	0.091	0.190
	$LSD_{0.01}$	0.439	0.109	0.209	0.324	0.123	0.256

According to the Duncan's test, means denoted by distinct letters signify significant differences across treatments ($p < 0.01$).

3.5. Nitrogen use efficiency (NUE)

Table 9 showed that Nitrogen use efficiency (NUE) grain yield of wheat (kg grain kgN^{-1})significantly increased with increasing of nitrogen fertilization and recorded the highest values (22.91 and 22.91 kg grain kgN^{-1}) up to 80 kg fed^{-1} for the 1st and 2nd seasons, respectively. It might be in put in NUE values in descending order as affected by N-fertilizer : $N_{80} > N_{120} > N_{160} > N_{40.}$ According to the same data, the mean values of NUE grew dramatically as molasses was added, reaching their highest values (19.14 and 20.94 kg grain kgN^{-1}) for the first and second seasons, respectively, when molasses application was raised to 90Lfed.$^{-1}$.It might put NUE in descending order as affected by molasses application : $M_{90} > M_{60} > M_{30} > M_0$. Nitrogen use efficiency was significant increased due to the interaction between the nitrogen fertilization and molasses application and recorded (25.59 kg grain kgN^{-1}) with N_{80} * M_{60} for the 1st and (28.06 kg grain kgN^{-1}) due the interaction between to N_{80} and M_{90} for the 2nd seasons as shown (Table 6). Fig.2a showed that linear relation betweenNitrogen use efficiency (NUE) and N-fertilization :to get the maximum value of these equations, first derivatives have to equal zero subject to the second derivatives be negative, N-(103.64 and 104.0 kg fed^{-1})which give maximum

NUE (20.90 and 22.87 kg grain kgN^{-1}) for the 1st and 2nd seasons, respectively.While Fig.2b showed that linear relation between N-recoverey(%) and molases –application :to get the maximum value of these equations, first derivatives have to equal zero subject to the second derivatives be negative, Molasses-(77.43 and 80.64 L fed^{-1}) which give maximum NUE (19.50 and 20.77 kg grain kg N^{-1}) for the 1st and 2nd seasons, respectively

3.6. N-Recovery (%)

Table 9 demonstrated that N-Recovery (%) by wheat yield grew significantly as nitrogen fertilization increased, reaching its greatest values (54.34 and 58.84%) at 160 kg fed^{-1} for the first season and the second season, respectively. It could be put N-Recovery (%) values in descending order as affected by N-fertilizer : N_{160}> N_{120}> N_{80}> $N_{40.}$ The same data showed that mean values of N-Recovery (%)was significantly increased with increasing molasses and recorded highest values (47.80 and 52.25 %) by increasing molasses application up to 90 $Lfed^{-1}$ for the 1st and 2nd seasons, respectively. It could be put N-Recovery (%) values in descending order as affected by molasses application : M_{90} > M_{60} > M_{30} > M_0. N-Recovery (%) was significant increased due to the interaction between the nitrogen fertilization and molasses application and recorded (62.66 and 67.68%) with N_{80} * M_{90} for the 1st and 2nd seasons as shown (Table 9). Fig.2c showed that linear relation between N-recoverey and N-fertilization to get the maximum value of these equations, first derivatives have to equal zero subject to the second derivatives be negative, N- (104.52 and 105.04 $kgfed.^{-1}$) which give (50.257 and 53.757%) maximum N-recoverey (%) for the 1st and 2nd seasons, respectively. While Fig.2d showed that linear relation between N-recovereyandmolases –application :to get the maximum value of these equations, first derivatives have to equal zero subject to the second derivatives be negative, M- (83.31 and 80.74$Lfed.^{-1}$) which give (47.49 and 51.75 %) maximum N-recoverey (%) for the 1st and 2nd seasons, respectively

Table 9. Mean values of NUE (grain yield of wheat, kg grain kgN^{-1}) and Nitrogen recovery (%) as affected by N-fertilization, molasses application and the interaction (N*M) during the two growing seasons (2022 &2023).

Treatments		NUE(kg grain $kgN.^{-1}$)		N-Recovery (%)	
Nitrogen ($kg\ fed^{-1}$)	Molasses ($L\ fed^{-1}$)	2021/22	2022/23	2021/22	2022/23
40	0	9.43o	9.99o	23.15p	25.17o
	30	11.62n	12.19n	28.40o	30.79n
	60	11.99m	12.36m	30.53l	32.97l
	90	12.39k	13.52k	32.50k	35.76k
80	0	15.70i	17.07i	35.55j	38.26j
	30	24.77c	26.94c	57.84c	63.28c
	60	25.59a	27.91b	61.32b	66.13b
	90	25.56b	28.06a	62.66a	67.68a
120	0	12.263	13.53k	29.62m	32.78l
	30	17.56g	19.02g	42.45g	45.57g
	60	18.33e	20.19e	45.47e	49.69f
	90	20.69d	22.37d	51.23d	54.99d
160	0	11.81l	12.84l	28.83n	31.62m
	30	15.14j	16.67j	37.74i	41.35i
	60	16.43h	17.79h	41.61h	44.78h
	90	17.83f	19.80f	44.99f	50.59e
N	F_{test}	**	**	**	**
	$LSD_{0.05}$	0.045	0.067	0.176	0.176
	$LSD_{0.01}$	0.070	0.101	0.268	0.267
M	F_{test}	**	**	**	**
	$LSD_{0.05}$	0.035	0.043	0.147	0.131
	$LSD_{0.01}$	0.047	0.059	0.199	0.178
Interaction (N x M)	F_{test}	**	**	**	**
	$LSD_{0.05}$	0.070	0.087	0.294	0.262
	$LSD_{0.01}$	0.095	0.118	0.398	0.356

Means followed by different letters indicate significant differences among treatments according to the Duncan's test ($p < 0.01$).

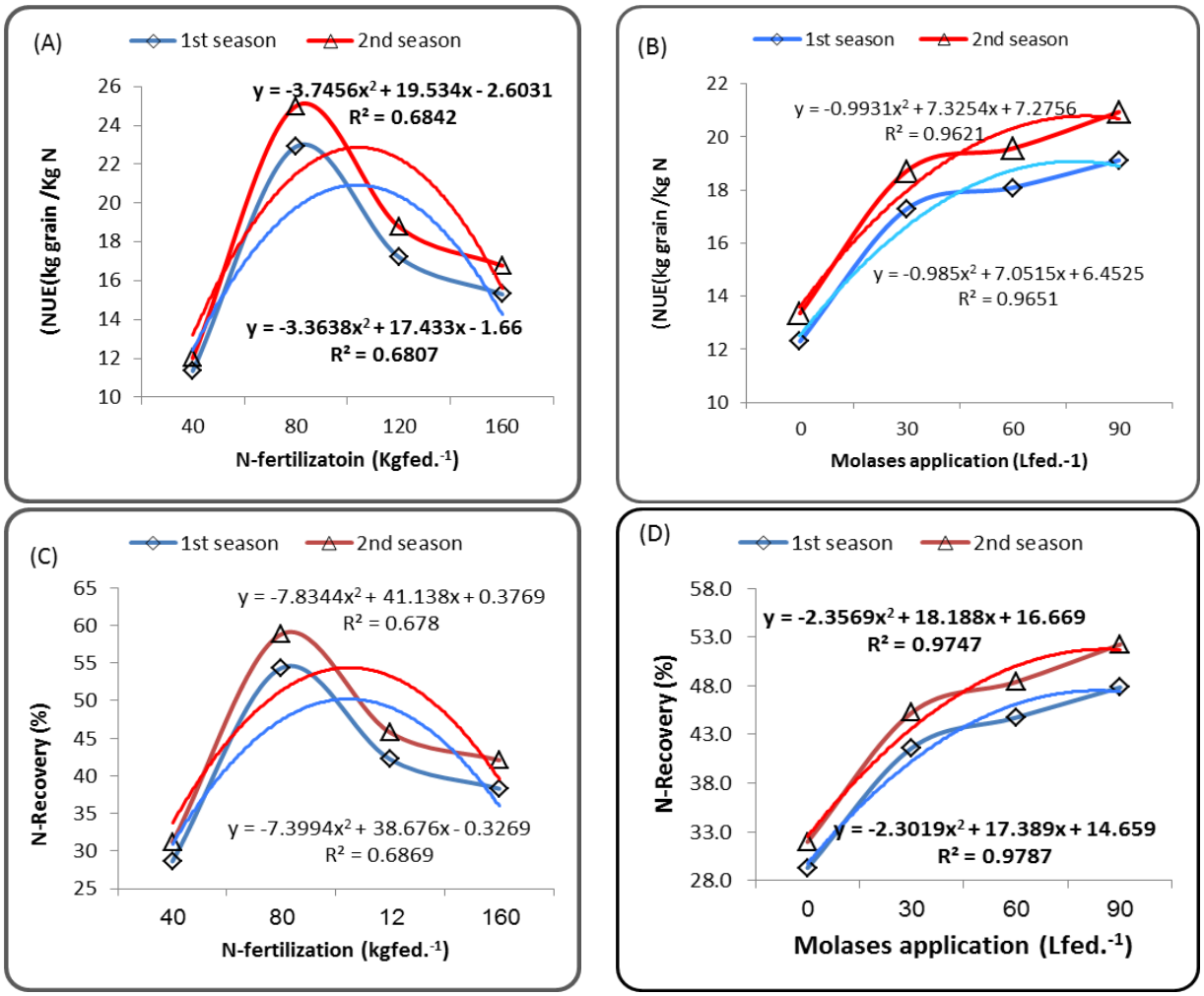

Fig. 3. NUE (grain kgN^{-1}) and Nitrogen recovery (%) by wheat as affected by N- fertilization and molasses application for the two growing seasonsp 2021/22 and 2022/23.

3.7. Economic evaluation of N-and molasses application treatment on wheatyield

Table (10) showed that increasing the amount of nitrogen fertilizer enhanced the total return by wheat yield, with the first and second seasons recording the greatest values (19875 and 34532 LE fed^{-1}) up to N160, respectively. Additionally, the same data demonstrated that increasing the amount of molasses applied enhanced the total return by wheat yield, with the first and second seasons recording the greatest values (13612 and 23587 LE fed^{-1}) up to M90, respectively.Table (10) demonstrated that the overall return on wheat yield improved as N fertilization and application molasses increased. The interaction between N160 and M90 for the 2021–2022 and 2022–2023 seasons, respectively, produced the highest values (22587 and 40251 LE fed^{-1}).Additionally, increasing the amount of nitrogen fertilizer enhanced the net return by wheat yield, which reached its highest value (8414 and 20666 LE fed^{-1}) for the first and second seasons, respectively. Additionally, the same data demonstrated that increasing the amount of molasses applied enhanced the total return by wheat yield, with the first and second seasons recording the greatest values (3419 and 11436 LE Fed^{-1}) up to M90, respectively.

Table (10) demonstrated that net return rose when N-fertilization and molasses increased. The interaction between N160 and M90 for the 2021–2022 and 2022–2023 seasons, respectively, produced the greatest values (10901 and 26159 LEfed.$^{-1}$).Table (10) demonstrated that raising the amount of nitrogen enhanced the benefit-cost ratio by wheat yield, with the first and second seasons recording the highest values (0.73 and 1.5) up to N160, respectively. Additionally, increasing the amount of molasses applied raised the benefit-cost ratio by wheat yield, which reached its highest values (0.27 and 0.80) up to M90 for the first and second seasons, respectively.Table (10) demonstrated that the benefit cost ratio of wheat yield rose when N and molasses levels increased. The interaction between N160 and M90 for the 2021–2022 and 2022–2023 seasons, respectively, produced the greatest values (0.93 and 1.86).

Table 10. Economic evaluation of yield of wheat as affected by N-fertilization and molasses application in the two growing season (2021/2022 and 2022/2023).

Treatments		Variable cost		Total cost LE fed^{-1}		Total return LE fed.$^{-1}$		Net return (NR) LE fed^{-1}		Benefit cost ratio (BCR)	
Nitrogen (kgfed$^{-1)}$	Molasses (Lfed$^{-1)}$	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0	0	0	0	8250	9760	1842	3085.5	-6408	-6674.5	-0.78	-0.68
	30	150	150	8400	9910	1907	3252.2	-6493	-6657.8	-0.77	-0.67
	60	300	300	8550	10060	2069	3531.2	-6481	-6528.8	-0.76	-0.65
	90	450	450	8700	10210	2103	3537.3	-6597	-6672.7	-0.76	-0.65
40	0	746.6	970	8996.6	10730	4654	7867.5	-4342	-2862.9	-0.48	-0.27
	30	896.6	1120	9146.6	10880	5310	9040.3	-3837	-1840.1	-0.42	-0.17
	60	1046.6	1270	9296.6	11030	5619	9530.9	-3678	-1499.4	-0.40	-0.14
	90	1196.6	1420	9446.6	11180	5809	9952.8	-3638	-1227.6	-0.39	-0.11
80	0	1493.1	1941	9743.1	11701	11159	19016.1	1416	7315.3	0.15	0.63
	30	1643.1	2091	9893.1	11851	16389	28444.4	6496	16593.6	0.66	1.40
	60	1793.1	2241	10043.1	12001	17263	29497.7	7220	17496.9	0.72	1.46
	90	1943.1	2391	10193.1	12151	17350	29632.4	7156	17481.6	0.70	1.44
120	0	2239.7	2911	10489.7	12671	12764	22100.3	2274	9429.1	0.22	0.74
	30	2389.7	3061	10639.7	12821	17522	29792.5	6882	16971.3	0.65	1.32
	60	2539.7	3211	10789.7	12971	18271	31665.5	7481	18694.4	0.69	1.44
	90	2689.7	3361	10939.7	13121	20214	34563.8	9274	21442.7	0.85	1.63
160	0	2986.3	3882	11236.3	13642	15726	26978.9	4489	13337.4	0.40	0.98
	30	3136.3	4032	11386.3	13792	19875	34303.8	8489	20512.3	0.75	1.49
	60	3286.3	4182	11536.3	13942	21316	36596.5	9779	22654.9	0.85	1.62
	90	3436.3	4332	11686.3	14092	22587	40251.3	10901	26159.7	0.93	1.86

Total fixed cost (fertilizer both of potassium and phosphor as well as tillage, seeds irrigation and harvest was (8250 and 9760 LE fed^{-1}) for growing seasons 2021/2022 and 2022/2023, respectively.The price of local market of grain yield of wheat in Egypt (5.9LE kg^{-1} and 10.0 LE kg.$^{-1}$) for the 2021/2022 season and straw (1.34LEkg^{-1} and 1.54 LE kg^{-1}) for the 2021/2022 seasons. The variable cost (18.665 and 24.25 LE KgN^{-1}) for the two growing seasons (2021/2022 and 2022/2023) and 5 LE L^{-1} molases in the both the two growing seasons (2021/2022&2022/2023).

4. Discussion

The application of molasses at rates up to 90 L/feddan led to a notable drop in soil bulk density while boosting soil porosity considerably. When molasses and N application rates were increased, the availability of essential nutrients like N, P, and K improved significantly, with the best results occurring when N160 was combined with M90. This improvement likely happens because molasses is packed with organic carbon and various mineral nutrients including N, P, K, Mg, Ca, S, Fe, and several vital micronutrients, which has been confirmed by multiple research studies conducted by **Amer (2015), El-Tokhy and colleagues (2019), Gaafar and team (2019), Kozminskaet al., (2021), and Omaraet al. (2022).**

The size of the flag leaf, number of spikes per square meter, and the weight of 1000 grains in wheat plants got much better when farmers used more N and molasses together, especially when they combined 160 units of N with 90 units of molasses over two growing seasons. The best results happened when they added 160 kg of N/feddan, probably because N is so important for how plants get their nutrition - it helps them stay green and photosynthesize better, which means they can make more proteins and carbohydrates. Other researchers like

Ibrahim (2021) and **Rashed et al. (2022**) found similar things, showing that adding molasses really does help wheat grains get heavier.

According to research by **Schenck (2001)** and **Chikhoune et al. (2014**), molasses changes the carbon to nitrogen balance in soil, which impacts how soil microbes work and creates better conditions for plants to thrive. When farmers used more nitrogen fertilizer up to 160 kilograms /feddan, wheat crops produced higher yields and the grain had more protein. The best results came when researchers combined nitrogen fertilizer with molasses - specifically when they used 160 kg of N along with 90 L. of molasses, which gave the highest grain and straw production. This improvement likely happens because molasses contains essential minerals and trace nutrients that help create a better growing environment for plants. These findings match up with what other researchers have found in earlier studies, including work by **Schenck (2001), Wynne and Meyer (2002), Raad (2011), Faizy et al. (2012), Sharma and Singh (2017), Ibrahim (2021), and Rossini et al.(2025).**

This shows how important it is to use molasses and nitrogen fertilizer together to get the best wheat yields and improve various wheat characteristics. When you combine 160 kg of N with 90 L of molasses, you end up with higher total and net profits, plus a better benefit-to-cost ratio. The reason this works so well is probably because molasses does amazing things for soil - it makes both the physical structure and chemical makeup better. Plus, molasses is packed with sugars and other essential compounds like organic acids that help plants absorb nutrients more easily **(Amer, 2015 and Omara et al. 2022).**

When you apply 103.64 and 104.0 kg /feddan, you get the best nitrogen use efficiency at 20.90 and 22.87 kg of grain / kg of N for the first and second growing seasons. Using 77.43 and 80.64 L of molasses /feddan also gives you the highest N use efficiency, with 19.50 and 20.77 kg of grain / kg of N in the first and second seasons. For N recovery, the best results come from applying 104.52 and 105.04 kg /feddan, which gives you 50.25 and 53.75 % recovery in the first and second seasons. When it comes to molasses, using 83.31 and 80.74 L/feddan gets you the best N recovery at 47.49 and 51.75 % for the first and second seasons. These findings match up with what **Amer et al. (2015),** and **Ibrahim (2021)** - basically that adding molasses to the soil really helps with nitrogen use efficiency and recovery. The financial side looks good too - total returns, net returns, and the benefit-to-cost ratio for wheat yields all went up when more N fertilizer and molasses were used. The sweet spot was using 160 kg of N/feddan combined with 90 L of molasses /feddan. This lines up with earlier research from **Amer et al. (2009), Ibrahim (2021), and Omara et al. (2022).**

5. Conclusion

It could be concoluded that yield of wheat responded to the interaction between 160 kg of N/ feddan and 90 L of molasses / feddan, the best results for total profits, net profits, and the ratio of benefits to costs. Also, adding 90 L of molasses / feddan really boosted the levels of N, P, and K that plants could actually use from the soil. Additionally, the most efficient N use when applied about 104 kg of N and 79 L of molasses / feddan. The plants recovered N best with slightly different amounts - around 105 kg of N and 82 L of molasses / feddan .For getting the biggest grain harvest, the sweet spot was using about 148 kg of N and 84 L of molasses / feddan. to maximize straw production instead by 145 kg of N and 78 L of molasses / feddan.

Declarations

Ethics approval and consent to participate

Consent for publication: There is nothing in the article that might be illegal, defamatory, or that would in any way breach the terms and conditions of the agreement if it were published.

Availability of data and material: Not applicable.

Competing interests: The authors of the paper affirm that they have no competing interests.

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Reference

A.O.A.C. (1980) Association of Official Agric. chemists. (Official Methods of Analysis), 13th Ed., Washington, D.C.

Abd El-Azeem; A.S. (2023)Response of sugar beet to application of molasses with bio and nitrogen fertilization.Ph.D. Faculty of sugar and Integrated Industries Technology, AssiutUniv.,EGYPT

Abofard M.M., Abdel-Aal M. G., Abde-Mogib M., Bakr M.N. and AbouElwafa S.F.(2021) Effect of the application of molasses and vinasses on the yield and quality of sugar beet and soil fertility.Egyptian Sugar J., 17, 23: 40

Adi N. P., NándorP., Zsolt K., Katalin J. (2023)The Effect of Molasses Application on Soil Biological Indicators and Maize Growth of Different Tillage Soil: A Pot Experiment, J. of Environmental Geography 16 (1–4), 119–124. DOI:10.14232/jengeo-2023-44670

Amer, M.M. (2005) Effect of N-, K-levels, and timing of application on some yield components of wheat varieties in the North Middle Delta Region Thesis; M.Sc.; Soils, Tanta Univ. Fac. of Agric., KafrELSheikh.

Amer, M.M. (2009) Response of Wheat Yield to Fertilization by nitrogen, Potassium and Biofertilizers in Salt Affected Soils. A Thesis Ph.DinAgric.Sci.(Soil) Dept. of Soil Sci. Faculty of Agric. Kafr El-Sheikh Univ.

Amer, M.M. (2015). Effect of gypsum, sugar factory lime and molas on some soil proprieties and productivity of sugar beet (Beta vulgaris L.) grown on saline-sodic soils of Nile North Delta. J. Soil Sci. and Agric. Eng., Mansoura Univ. ;6(3):385-401.DOI: 10.21608/JSSAE.2015.42170

Atia, R. H., and Ragab, K. E. (2013) Response of some wheat varieties to nitrogen fertilization. J. of Soil Sci. and Agric. Engineering, 4(3), 309-319.

Chikhoune, A., Bedjou, F., Oubouzid, S., Boukefoussa, R., Bechri, B., andTarmoul, H. (2014). Development of sugar cane molasses in formulations of madeleines, mini croissants, and buns incorporated with inter esterified oil. J.of Chemistry.

Crasswell. E. T. and Godwin D. C. (1984) The efficiency of nitrogen fertilizers applied to cereals in different climates. Adv. Plant Nutrition 1, 1 –55.

El-Bialy S.M., El-Esawy T., El-Ramady H., El-Mahrouk M.E., El-Sakhawy T., Omara A E., Amer M.M., El-Serpiny M. A., Eid Y. and Eric C. B. (2025) Integrated Fertilization to Support Crop Productivity in Saline Soils. Egypt. J. Soil Sci. Vol. 65, No. 3, pp: 1365 - 1382

El-Refaey, R., EH, E. S., Atta, M., Zahran, G., and El-Hadidy, N. (2023) Eeffectof Nitrogen Fertilizer Levels and Irrigation Regimes on Yield and Yield Components of Some Wheat Cultivars Menoufia J. of Plant Production, 7(9), 235-247.

El-Tokhy F.K., Tantawy A.S, El-Shinawy M.Z., Abou Hadid1 A.F. (2019) Effect of Sugar Beet Molasses and Fe-Edhhaon Tomato Plants Grown Under Saline Water Irrigation Condition. Arab Univ. J. Agric. Sci. (Aujas), Ain Shams Univ., Cairo, Egypt Special Issue, 26(9d), 2297- 2310, Website: Http://StrategyPlan.Asu.Edu.Eg/Aujasci/

Faizy S., Rezk M.M, Gazia E.A., Amer M.M.(2012) Effect of N, K and N application time on yield and uptake of wheat plants at North Delta- J.of Soil Sci. and Agric. Engineering.

Faizy S.,Rizk M.M, Ragab M.M, Amer M.M.(2010) Response of wheat yield and apparent nitrogen recovery of fertilizer to mineral nitrogen and biofertilizer application in salt affected soils. J.Agric.Res.Kafer El-Sheikh Univ 36(1):74-96.

FAO (2000) Fertilizers and their Use, Evaluation of Fertilizer Demonstrations.A pocket guide for extension officers. Fourth edition. Food and Agric. organization of the United Nations International Fertilizer Industry Association Rome, Fourth edition.

Gaafar S. M.; NMM EL-Shimi, Helmy M.M (2019) Effect of Foliar and Soil Application of Some Residuals of Sugar Cane Products (Molasses and Vinasses) with Mineral Fertilizer Levels on Growth, Yield and Quality of Sweet Pepper. Menoufia J. Plant Prod. (4): 353 – 373

Gomez, K.A., and Gomez, A.A.(1984) "Statistical procedures for agricultural research". John Wiley and Sons, Inc., New York.pp:680.

Ibrahim. E. A. (2021) Effect of Some Culthure Practices to Reduce the Impact of Soil Salinity on Wheat Crop in North Delta, Thesis M.Sc. Agronomy Dept., Faculty of Agric.,Kafrelsheikh Univ.

Klute, A. (1986) Methods of Soil Analysis part 1, Physical and Mineralogical Methods. Am. Soc. of Agrom. and Am. Soc. soil sci.MethodsMadison,Wisconsin,USA.

Kozminska, A.; Hanus- Fajerska, E.; Halecki,W.; Ciarkowska, K.(2021) Beet Molasses Enhance Salinity Tolerance in Thymus serpyllum—A Study under Greenhouse Condition. Plants, 10, 1819. https://doi.org/10.3390/plants10091819

Ministry of Agriculture and Land Reclamation, Economic Affairs Sector. (2022). Bulletin of Agric. Statistics: Part (1) Winter Crops, 2024/2022. Arab Republic of Egypt

Naveed, S., Rehim, A., Imran, M., Anwar, M. F., and Hussain, S. (2018) Effect of distillery spentwash fertigation on crop growth, yield, and accumulation of potentially toxic elements

Omara A.E. , M. Aiad , Abo-Elela E. G., El-Ramady H. and Amer M.M. (2022) Significant Use of Molasses and Foliar Application of Ca(NO3)2 on Improving of Some Soil Properties and Yield of Rice under Salt Affected Soils, Env. Biodiv. Soil Security, Vol. 6, pp: 285 - 297

Owen, P.C. (1968) A measuring scale for areas of cereals leaves, Exp. Agric. 4 (4): 275-278.

Pyakurel A., Bhishma R. D., Swodesh R.(2019) Effect of Molasses and Organic Fertilizer in Soil fertility and Yield of Spinach in Khotang, NepalInt. J. Appl. Sci. Biotechnol. Vol 7(1): 49-53

Rashed S.H., Sorour S. , Aelhag D. and Amer M.M. (2022) Effect of Some Organic Substances and Foliar Application of Nano- Silica on Physico-Chemical Soil Properties and Yield of Wheat in Salt Affected Soils. Inter. J. of Plant & Soil Sci.. 34(2): 15- 27, 2022; Article no.IJPSS.83472. DOI: 10.9734/IJPSS/2022/v34i230832

Rossini, A., Ruggeri, R., & Rossini, F. (2025) Combining nitrogen fertilization and biostimulant application in durum wheat: Effects on morphophysiological traits, grain production, and quality. Italian J. of Agronomy, 20(1), 100027.

Sanli A, Karadogan T., Tosun B. (2015) The effects of sugar beet molasses application on root yield and sugar content of sugar beet (Beta vulgaris L.). TarlaBitkileriMerkezArastirmaEnstitusuDergisi 24 (2):103-108

Schenck S (2001) Molasses Soil Amendment for Crop Improvements and Nematode Management. Hawaii: Hawaii ARC.

Shahin, M. G. (2020) Nitrogen recovery efficiency and grain yield response index of some wheat varieties as affected by nitrogen fertilizer rates. Middle East J, 9(4), 1101-1113

Wu, Y., Yan, S., Fan, J., Zhang, F., Zheng, J., Guo, J., et al. (2020) Combined application of soluble organic and chemical fertilizers in drip fertigation improves nitrogen use efficiency and enhances tomato yield and quality. J. Sci. Food Agric. 100, 5422–5433. doi: 10.1002/jsfa.10593

Wynne A.T., Meyer J.H. (2002) An Economic Assesment of Using Molasses and Condensed Molasses Solids as a Fertilizer In South African Sugar Industry. Mount Edgecombo: South African Sugar Association Experiment Station

Yash, P. K. (1998) Handbook Reference Methods for Plant Analysis. Taylor & Francis Group, London.

Zhao, H., and Si, L. (2015) Effects of topdressing with nitrogen fertilizer on wheat yield, and nitrogen uptake and utilization efficiency on the Loess Plateau. ActaAgric.Scandinavica, Section B—Soil & Plant Sci., 65(8), 681-687.