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Significant Use of Molasses and Foliar Application of $Ca(NO_3)_2$ on Improving of Some Soil Properties and Yield of Rice under Salt Affected Soils

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A FIELD experiment was conducted at Kafr El- Sheikh Governorate, North Nile Delta area, Egypt during the two successive growing seasons 2020 and 2021 to assess the effect of different levels from molasses and foliar application of Ca $(NO_3)_2$ on some soil properties and yield of rice**.** Spilt- plot design was used, which the main plots were assigned to four treatments of molasses (i.e., M1: without molasses, M2:140 L ha^{-1}, M3: 280 L ha^{-1}**,** M4:420 L ha^{-1}), while foliar application of $Ca(NO_3)_2$ treatments were assign to sub main plots (i.e., Ca1: foliar as tab water, Ca2: 0.5 g l^{-1} and Ca3: 1 g l^{-1}). Results revealed that after the two growing seasons, increasing molasse application up to 420 L ha^{-1} led to a decrease in soil bulk density. Soil porosity had a different trajectory than bulk density, recording its greatest values during the same prior treatment. With an increase in molasses up to 420 L ha^{-1}, available concentrations of N, P, and K in soil as well as dehydrogenase, urease and total count of bacteria were greatly enhanced, with M4 and Ca3 recording the greatest levels. The interaction effect of the molasses treatment and foliar application of $Ca(NO_3)_2$ led to a highly significant increase in the chlorophyll content, 1000-grain weight, grain, straw yield, and total N-uptake. According to the trial, farmers could gain from using molasses and foliar application of $Ca(NO_3)_2$ because it boosts rice harvest while enhancing soil physical, microbiology and its fertility.

Keywords: Soil dehydrogenase, Bacteria count, Soil porosity, Soil bulk density, Rice, ESP.

1. Introduction

Soil salinity and sodicity may cause soil degradation, which consider a serious limitation to crop production. Improving both of salt affected soils and rice productivity may be achieved by using soil amendments and fertilizer at the North Delta in Egypt. Insufficient soil amendments, insufficient sustainable soil management, and poor soil fertility are considered the main causes of Egypt's decline of the yield of several crops (Khalifa et al. 2022).

A large amounts of sugar beet industrial by-products are produced from beet sugar factories, which may lead to environmental pollution. Molasses is produced annually in large amounts and is used in different industries including animal feeding, alcohol and fertilizers. The use of sugar beet molasses in agriculture stimulates nutrient elements uptake efficiency and soil biological activity (Samavat and Samavat 2014), supplies carbohydrates and alters C: N ratio which affects soil microbial ecology and lowers plant parasitic nematodes as well as provides other favorable effects on plant growth (Schenck, 2001) and improves soil aggregation, reduces surface crusting

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in hard-setting soils and microbial activity (Wynne and Meyer, 2002). As well as sterilize soil partially and increase nitrogen fixation (Rouillard, 1954) which contains 45 to 55 weight percent fermentable sugars in the form of sucrose, glucose, fructose and organic content including vitamins, minerals, proteins and amino acids (Raad, 2011). The decomposition of molasses produces carboxylic groups which, after dissociation may decrease soil pH, as soon as these groups are decarboxylated in the citrate cycle, an equivalent amount of protons is required inducing a rise in soil pH. (Yan et al., 1996). Molasses increases rate of nitrification in soil (Cleasby, 1959). Soil available potassium (Sanli et al., 2015).

Other amendments that have been applied for management of salt-affected soils include low-cost industrial by-products like molasses (Amer et al 2015; Gaafar et al 2019), which improve soil aggregation, increase soil hydraulic conductivity, and reduce clay dispersion in the soil, which aids in leaching undesirable ions from the soil (Sharma and Singh 2017) and with 75 % recommended mineral fertilization and with adding (288 Lha^{-1}) molasses as soil application improved the vegetative growth and fruits yield with best quality of sweet pepper plants compared with the control (mineral fertilization only) and save 25% from the fertilizer recommendation (Gaafar et al. 2019).The application of 200 $kgfed^{-1}$ beet sugar molasses, the residual syrup from sugar beet processing, to the soil surface significant effect in mitigating salinity negative effects and could enhance the physical and chemical properties of the soil (El-Tokhy et al. 2019).

The beneficial effects of NO_3 in delaying synthesis of abscisic acid and promotes cytokinin activity and causes higher chlorophyll retention and thereby higher photosynthesis activity in leaves for supply of Photosynth ate to grains (Sarkar et al. 2007). Calcium (Ca^{++}) is an essential part of plant cell wall; it forms calcium pectate compounds which give stability to cell walls and bind cells together; helps in protecting the plant against heat stress- Ca^{++} improves stomata function and participates in induction of heat shock proteins; participates in enzymatic and hormonal processes helps in protecting the plant against diseases; affects cereal quality; has a role in the regulation of the stomata (Mengel and Kirkby, 2001). Ca^{++} may substantially increase N, P uptake and this may prove to be helpful in promoting root growth (Friessen et al. 1980), constituent of cell wall and plays a key role in cellular functions and activity of enzymes (Bush, 1995). Presence of Ca^{++} may result in more rational utilization of soil N and more active assimilation of NO_3, N in roots and leaves (Kondratev et al. 1984). Tripathy et al. (2017) found that foliar application of 0.406% Ca $(NO_3)_2$ resulted in the highest grain yield of rice (6.54 t ha^{-1}) and foliar application treatments at 0.3% Ca $(NO_3)_2$ enhanced tomato yield and nutrient uptake.

The main objective of the present study is to investigate the effect of application of diluted molasses in a rice paddy field and Ca $(NO_3)_2$ on improved physically, fertility and soil enzymes properties as well as grain and straw yield of rice in salt affected soils at the North Delta, Kafr El-Sheikh Governorate.

2. MATERIALS AND METHODS

2.1 Experimental design

At Kafr El-Sheikh, Egypt (Latitude: 31° 10´ 35 11 N and Longitude: 30° 52´9.08 E), a field experiment (summer 2020 and 2021) was conducted in a split- plot design with three replicates to study the effect of different levels of molasses and foliar application of $Ca(NO_3)_2$ on some soil properties, physiological traits, soil enzymes, and yield of Rice (*Oryzaaestivum L* cvSakha108) under salt-affected soils. Soil properties of the experimental location are presented in Table 1. The plot area was 21 m^2. The main plots were divided into four treatments of molasses M1: without molasses, M2: molasses (140 L ha^{-1}), M3: molasses (280 L ha^{-1}) and M4: molasses (420Lha^{-1}) and the sub-plots were divided into three treatments of foliar application with $Ca(NO_3)_2$ (Ca1:0,Ca2:0.5g/l and Ca3: 1g/l) at 30day from transplanting and during 50% flowering stage. The Rice Research Center, Egypt, supplied the grains of Rice which sown on Jun5, 2020, and Jun10, 2021 and harvested on sept.30, 2020 and sept 28, 2021. In addition to applying N, P and K fertilizers was applied at a rate of 170, 37 and 60kg ha^{-1} as N, P_2O_5 and K respectively, P and K were mixed with the upper soil layer before tillage. After transplanting, N fertilizer was applied as ammonium sulphate. All agricultural practices and fertilization rates were performed according to the traditional recommendations in North Delta area.

2.2 Soil analysis

Before planting and after harvesting Rice crop, soil samples (0-20, 20-40 and 40-60 cm depth) were collected and composite (Table 1). Composite soil samples were dried, sieved through 2 mm mesh and analyzed for salinity that was determined in the saturated soil paste extract according to Sparks et al. (2020). The bulk density (BD, kg m^{-3}) was determined using core-ring method and one core per stratus of each plot was collected and the samples were oven dried for 48 h at 105^{oC}, weighed, bulk density and total porosity (TP, %) calculated according to Campbell (1998). In addition, particle size distribution was determined according to Allen, (1998). Available N and P was determined according to Page et al. (1982) Climatological data, potential evapotranspiration and maximum evapotranspiration during the two growing summer seasons 2020 and 2021 were showed in Table 2. Also, chemical composition of sugar beet molasses was presented in Table (3).

2.3 Plant analysis

Plant samples from the measured plants for chlorophyll content (SPAD unit), was measured on ten leaves taken from each replicate by chlorophyll meter (SPAD-502, Soil- Plant Analysis Department (SPAD) section, Minolta camera Co., Osaka, Japan). Triphenyl formazon (TPF, red-colored) was created by reducing 2, 3, 5- triphenylotetrazolium chloride (TTC) in order to measure the dehydrogenase activity (mg TPF g^{-1} soil day^{-1}) of soil samples according to (Casida et al 1964). Additionally, the amount of ammonium created by urea hydrolysis in soil was assessed as the amount of urease enzyme activity (mg NH_4^+- N g^{-1} soil day^{-1}) in soil samples (Pancholy and Rice 1973). 1000-grain weight and both of grain and straw yield of rice were calculated and recorded for each plot and calculated per hectare.

Table 1. Some physical and chemical properties of the experimental soil.

Soil depth (cm)	**Soil physical properties**								
	Soil moisture characteristics					**Particle size distribution** (%)			
	F.C (%)	**W.P. (%)**	**A.W. (%)**	**B.D. (kg m^{-3})**	**IR (cm/h)**	**Sand**	**Salt**	**Clay**	**Soil texture**
0-20	43.25	23.11	20.14	1.31		17.3	25.5	57.2	clay
20-40	40.22	20.08	20.14	1.32	0.61	18.05	24.63	57.32	clay
40-60	38.18	19.03	19.15	1.33		18.45	25.05	56.5	clay

Soil chemical properties						
Soil depth(cm)	**pH**	**EC (dSm^{-1})**	**ESP (%)**	**CEC ($cmol_c$ kg^{-1})**	**OM (%)**	**$CaCO_3$ (%)**
0-20	7.85	4.66	9.15	30.25	1.68	1.91
20-40	8.01	5.19	9.45	29.85	1.42	2.00
40-60	8.02	6.25	10.01	28.65	1.30	2.02

Available of macro elements (mg kg^{-1})		
N	P	K
24.5	7.55	305

F.C.: Field Capacity**; W.P.:** Wilting Point; **A.W.**: Available Water; **B.D.**: Bulk Density;**IR**: ;**pH**: was determined in soil water suspension (1:2.5); **EC**: was determined in saturated soil paste extract;**ESP:** Exchangeable Sodium Percent; **CEC:** Cation Exchange Capacity; **OM**: Organic Matter.

Table 2. Chemical composition of sugar beet molasses.

Item	%	Item	%	N.O.A*	%	vitamins	Value, mg kg^{-1}
NO_3	0.4	Sucrose	48	lactic	1.3	pyridoxine (B6)	0.5
PO_4	0.21	Water	20	citric, glycolic	0.75	thiamine (B1)	1.3
K^+	5	Starch	1	malic	0.75	riboflavin (B2)	0.4
Ca^{2+}	1.5	Polysaccharides	1	oxalic,	0.2		
Mg^{2+}	1.14	Dextrin, cellulose	3	succinic	0.2	Density (gcm^{-2})	1.47
Na^+	0.17	Total N content	10	acetic	0.2	O. M (non-sugars)	21.9(%)
Cl^{2-}	0.4	Crude protein	9.5	propinic	0.2		
SO_4	1.12	Glutamic acid	2.5	putyric	0.2		

* Non-nitrogenous organic acids

Table 3. Climatological data during the two rice growing seasons 2020/and 2021.

Season	Month	Temperature, C°			R.H %	W.S (m/s)	Precipitation (mm $month^{-1}$)
		Max	Min	Mean			
2020	Jun	35.90	19.39	27.64	50.97	3.36	0.0
	Jul.	37.71	22.00	29.86	54.99	3.21	0.0
	Aug.	38.00	22.88	30.44	56.65	3.10	0.0
	Sep.	37.67	22.69	30.18	58.92	2.94	0.0
2021	Jun	35.88	20.07	27.97	51.54	3.28	0.0
	Jul.	38.45	23.03	30.74	53.55	3.21	0.0
	Aug.	39.16	23.76	31.46	55.40	2.90	0.0
	Sep.	35.31	22.49	28.90	56.05	3.27	0.0

R.H.: relative humidity; **W.V.**: wind velocity (at 2 m height); **Source**: Meteorological station at Sakha Agric. Res. Station

Statistical Analyses

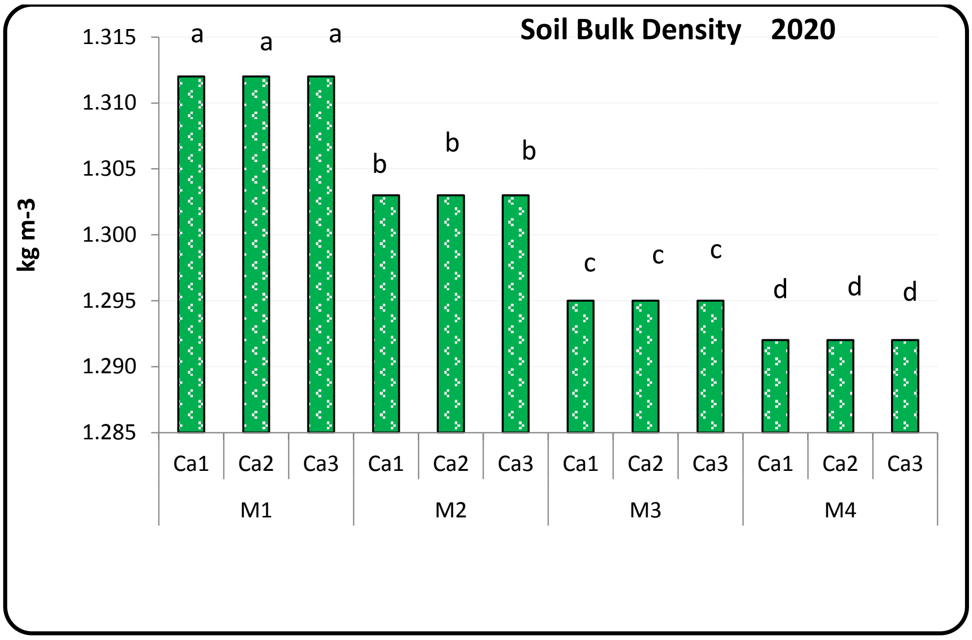
The data were examined using a split-split plot analysis of variances (ANOVA). The treatment means were compared using Duncan's multiple range test (Duncan, 1955).

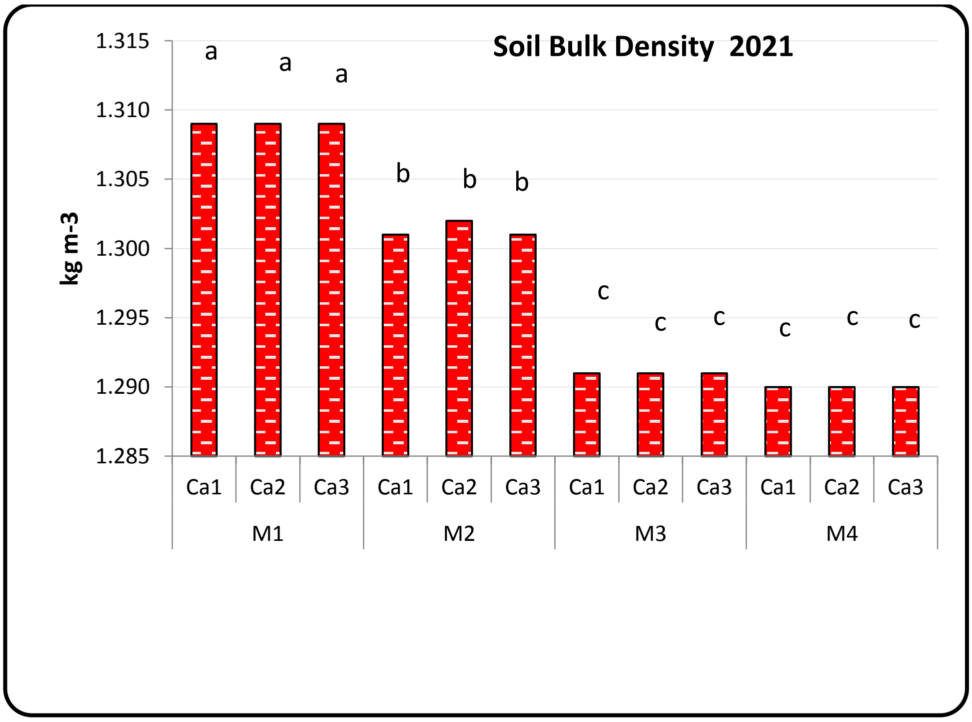
3. Results and Discussion

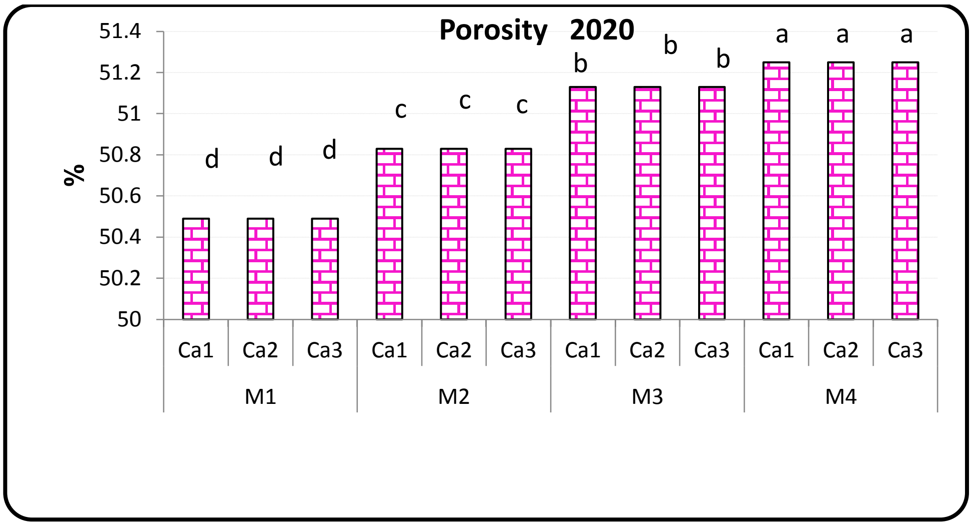
3.1 Soil physical properties

3.1.1 Soil bulk density and total porosity

Results in Fig.1 revealed that the soil application of molasses treatments seemed to be effective in producing relatively low values of soil bulk density. Soil bulk density (BD) ranged from 1.312 to 1.309 kgm^{-3} without treatment for two growing seasons, while with soil amendments, bulk density values (BD) were reduced and varied from 1.303 to 1.290 kgm^{-3}. Fig. 1 pointed out that BD recorded lowest values due to 280Lha^{-1} molasses application compared without treatment after the two growing seasons. The impacts were in the following order: M1> M2 >M3 >M4 treatment in both growing seasons. Soil porosity took the opposite trend of BD where soil porosity was recorded highest values by M4 (420L molasses/ha). Concerning the impact of the treatments on soil bulk density and total porosity, the impacts whereas a beneficial effect on the' structure of heavy clay soils with poor physical properties. It is supposed to improve their tilth and bring about an increase in the number and stability of the soil aggregates. The benefits in the physical properties of soil possible due to that molasses improves the hydro-physical properties such as BD, total porosity, soil aggregation and permeability that increase both of total porosity and drainable pores. Whereas the field area of study is a good drainage efficiency. In addition, humic substances stabilize soil aggregates for a long term in which they are mainly involved in the micro-aggregate formation. These results are supported by Amer et al. (2015), and Gaafar et al (2019). With respect to the effect of foliar application of Ca(NO_3)$_2$ on BD and total porosity after harvesting of rice yield, data pointed out that BD and total porosity were insignificant effect in both seasons. On the other hand, the BD and total porosity were non-significant affected by the interaction between the all treatments (Fig. 1).







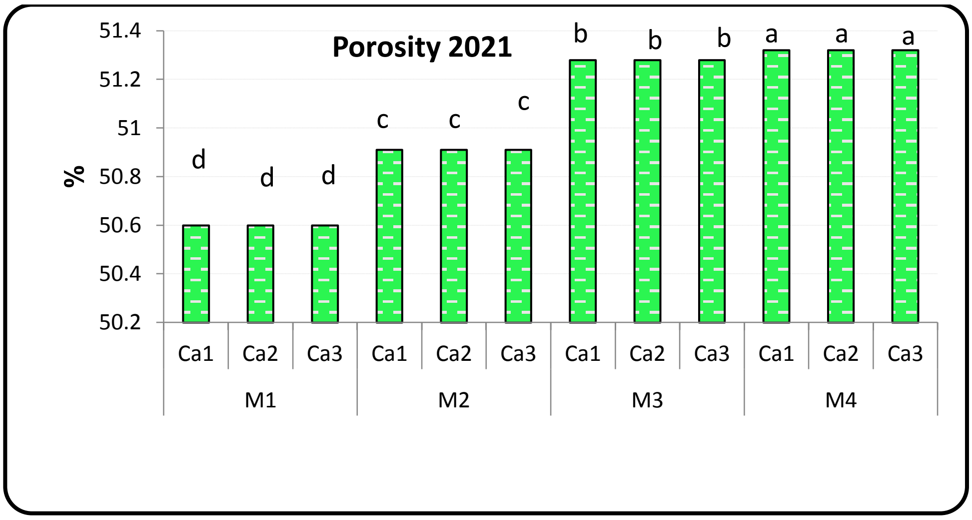


Fig.1. Soil bulk density and total porosity as affected by molasses and foliar application of nitrate calcium during two growing seasons. Notice, M1: without molasses, M2: 140L ha^{-1}, M3:280 L ha^{-1}, M4 :420 L ha^{-1}. Ca1: foliar as tab water without $Ca(NO_3)_2$,Ca2:0.5g L^{-1} and Ca3:1g L^{-1}.

3.2 Soil biological properties

Dual treatments with molasses and foliar application of nitrate calcium showed increases soil biological properties in the rhizosphere of rice plants significantly over the control treatment, M1Ca1 (Table 4). Generally, soil enzymes activity (dehydrogenase (DHA) and urease) and total counts of bacteria were noted to increase with increasing different rates of molasses and foliar application of Ca $(NO_3)_2$. The highest activity of DHA was 216.00 and 222.67 mg TPF g^{-1} soil day^{-1} followed by 201.33 and 209.67 mg TPF g^{-1} soil day^{-1} for M4Ca3 treatment (420 Lha^{-1} molasses + 1 g L^{-1} Ca $(NO_3)_2$) and M3Ca3 treatment (280 Lha^{-1} molasses + 1 g L^{-1} Ca $(NO_3)_2$) during 2020 and 2021 seasons compared to other treatments, respectively (Table 4). On the other hand, under different application rates of molasses, M4 treatment (420 Lha^{-1}) was the best treatment for urease enzyme activity recorded 76.33, 89.67 and 138.00 NH_4^+- N g^{-1} soil day^{-1} in season 2020 and 78.67, 91.67 and 143.33 NH_4^+- N g^{-1} soil day^{-1} in season 2021 for Ca1, Ca2 and Ca3 of Ca $(NO_3)_2$, respectively (Table 4). The same trend was observed in total count of bacteria that the following order: M4 > M3 > M2 > M1 for molasses treatment and Ca3 > Ca2 > Ca1 for Ca $(NO_3)_2$ in both growing seasons.

A balance of microorganisms, nutrients, animals, water, and air can be found in soil, which is a living thing with many different parts. Soil stability, health, and workability can all be improved by adding bio-stimulant to soil that is a source of carbon and nitrogen (Neff, et al. 2002). Blackstrap molasses is one example of a biostimulant that can boost the soil's microbial activity and, as a result, the health of the plants being grown (Mahmoud, et al. 2020; Adoko, et al. 2021). The higher rates of molasses solution (45 ml/3.8 L of water) exhibited significantly greater rates of CO_2 evolution and improved soil biological activity over a 4-week period, according to Waguespack et al. (2022). Abou-Hussien et al. (2020), showed that the application of molasses and vinasse together improved soil biological activity, such as dehydrogenase activities in the rhizosphere of sandy soil, and increased the vegetative development of common bean plants.

Table 4. Effect of molasses and foliar application of nitrate calcium on DHA (mg TPF g^{-1} Soil day^{-1}), Urease NH_4^{+} $^{-1}$ N g^{-1} Soil day^{-1}) and Total count of bacteria CFU (log 10) g^{-1}during 2020 and 2021 seasons.

Treatments		DHA (mg TPF g^{-1} Soil day^{-1})		Urease (NH_4^{+} $^{-1}$ N g^{-1} Soil day^{-1})		Total count of bacteria CFU (log 10) g^{-1}	
		2020	2021	2020	2021	2020	2021
M1	Ca1	50.00 ± 4.58 k	51.67 ± 3.51 k	45.33 ± 1.53 h	46.67 ± 2.08 h	3.81 ± 0.04 l	3.85 ± 0.04 l
	Ca2	74.00 ± 2.65 j	77.67 ± 0.58 j	58.33 ± 3.51 g	61.33 ± 1.53 g	4.19 ± 0.04 k	4.24 ± 0.06 k
	Ca3	80.00 ± 3.00 j	81.67 ± 3.21 j	89.00 ± 3.61 d	91.00 ± 3.46 d	5.25 ± 0.03 h	5.31 ± 0.03 h
M2	Ca1	104.67 ± 5.51 i	111.00 ± 2.65 i	57.00 ± 2.65 g	60.33 ± 4.73 g	4.88 ± 0.03 j	4.94 ± 0.03 j
	Ca2	147.33 ± 5.69 f	151.33 ± 3.51 f	71.00 ± 2.00 f	72.33 ± 3.21 f	5.48 ± 0.05 f	5.51 ± 0.04 f
	Ca3	184.33 ± 4.16 c	187.00 ± 3.61 c	97.00 ± 2.00 c	99.67 ± 2.08 c	6.03 ± 0.05 c	6.14 ± 0.06 c
M3	Ca1	122.33 ± 5.51 h	129.67 ± 1.53 h	68.67 ± 2.52 f	70.33 ± 3.51 f	5.13 ± 0.04 i	5.16 ± 0.06 i
	Ca2	158.33 ± 4.04 e	162.00 ± 3.61 e	77.67 ± 3.51 e	80.00 ± 4.58 e	5.69 ± 0.03 e	5.73 ± 0.04 e
	Ca3	201.33 ± 3.51 b	209.67 ± 1.15 b	124.33 ± 3.51 b	130.00 ± 3.61 b	6.17 ± 0.03 b	6.22 ± 0.03 b
M4	Ca1	134.33 ± 4.16 g	138.33 ± 4.04 g	76.33 ± 2.08 e	78.67 ± 1.53 e	5.40 ± 0.05 g	5.43 ± 0.09 g
	Ca2	172.00 ± 4.58 d	175.33 ± 3.79 d	89.67 ± 3.06 d	91.67 ± 3.51 d	5.85 ± 0.03 d	5.89 ± 0.02 d
	Ca3	216.00 ± 5.57 a	222.67 ± 5.51 a	138.00 ± 4.58 a	143.33 ± 4.51 a	6.32 ± 0.06 a	6.37 ± 0.07 a
Main							
$LSD_{0.05}$		4.74	2.49	2.52	2.12	0.034	0.066
$LSD_{0.01}$		6.23	3.78	3.82	3.21	0.052	0.1
Sub-main							
$LSD_{0.05}$		3.69	2.09	1.53	1.39	0.032	0.034
$LSD_{0.01}$		5.09	2.87	2.11	1.91	0.044	0.047
Interaction							
$LSD_{0.05}$		7.39	4.18	3.06	2.78	0.064	0.069
$LSD_{0.01}$		10.19	5.75	4.22	3.83	0.088	0.095

Notices: M1: without molasses, M2: 140L ha^{-1}, M3:280L ha^{-1}, M4 :420Lha^{-1}. Ca1: foliar as tab water without $Ca(NO_3)_2$,Ca2:0.5g L^{-1} and Ca3:1g L^{-1}.

3.3Soil available macronutrient

The soil fertility of salt-affected soils is considered an important issue, which needs a suitable management to overcome the salinity and/or sodicity of these soils. The results presented in Fig. (2) exhibit the effect of different level of molasses treatments on soil fertility after harvesting of rice. Data indicated that available N, P and K in soil were significantly increased by increasing application of molasses. it recorded the highest values up to 420lha^{-1}. The same data pointed out that the available soil of N, P and K were insignificantly affected by foliar application of $Ca(NO_3)_2$. Concerning the interaction among treatments, the same data showed that available N, P and K in soil after harvesting of rice yield were significantly increased and recorded highest values with M x Ca. These results may be due to the action of molasses on the soil is glibly spoken of as an effect on the micro-organic population. It appears that. There is a partial sterilization of the soil, with a corresponding change in the colonies and populations of organisms. The outcome of this is a possible increase in nitrification, resulting in an increase in the soil nitrogen in a form available to the plant. These results supported by El-Ramady et al. (2022).

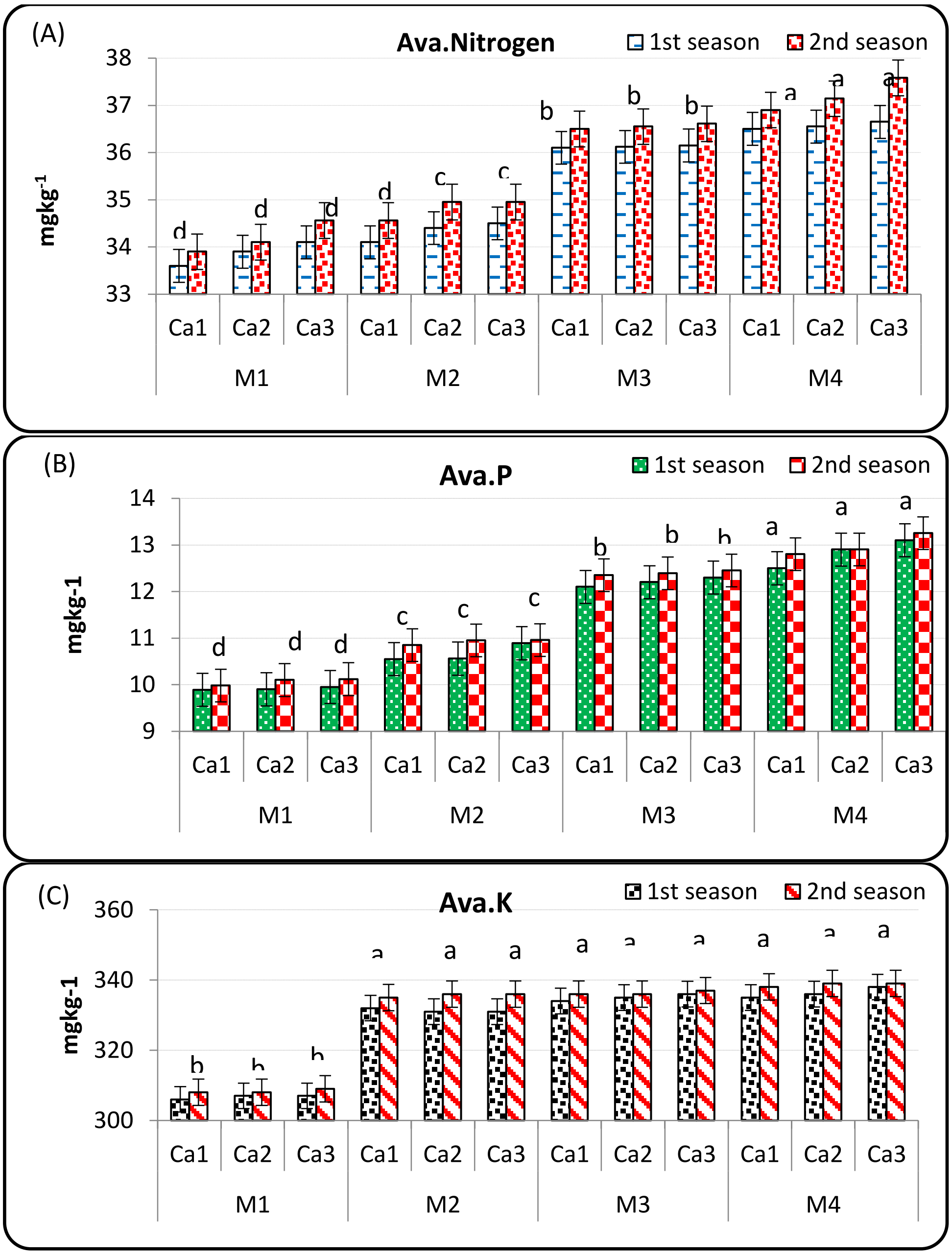


Fig (2). Availability of Nitrogen, Phosphor and Potassium in soil as affected by molasses and foliar application of nitrate calcium after two growing season 2020 and 2021. Notices, M1: without molasses, M2: 140Lha^{-1}, M3: 280Lha^{-1}, M4: 420Lha^{-1}; Ca1: foliar as tab water without $Ca(NO_3)_2$,Ca2:0.5gL^{-1} and Ca3:1gL^{-1} .

3.4 Chlorophyll and 1000-Grain weight

Chlorophyll content and 1000-grain weight of rice are listed in Table 5. With respect to the effect of molasses and foliar application of $Ca(NO_3)_2$, it is pointed out that chlorophyll (SPAD) and 1000-grain weight of rice were highly significantly increased with application of molasses and foliar application of $Ca(NO_3)_2$comparing with control during both growing seasons. With respect to the effect of foliar application of $Ca(NO_3)_2$, data pointed out that chlorophyll (SPAD) and 1000-grain weight values were significant increased with different treatments as compared with the control in both seasons as shown in Table 5. On the other side, it could be concluded that chlorophyll (SPAD) and 1000-grain weight were highly significantly increased due to the interaction between the soil application of molasses and foliar of $Ca(NO_3)_2$. The data showed that chlorophyll (SPAD) and 1000-grain weight were recorded the highest values of chlorophyll (SPAD) (38.57 and 38.83 (SPAD) and 1000-grain weight (22.21 and 22.34) were obtained due to the interaction between of M4 and Ca3 in the two growing seasons. These results are supported by Friessen et al. (1980), Mengel and Kirkby (2001) and Sarkar et al. (2007).

Table 5. Combined effects of molasses and foliar application of nitrate calcium on chlorophyll and 1000-Gw of rice during 2021 and 2022 seasons.

Treatments		Chlorophyll content (SPAD value)		1000-GW (g.)	
		2020	2021	2020	2021
M_1	Ca_1	37.89 ± 0.03g	38.09 ± 0.03h	21.76 ± 0.03k	21.89 ±0.03k
	Ca_2	37.92 ± 0.02g	38.12 ± 0.03g	21.80 ± 0.01 j	21.93 ± 0.02 j
	Ca_3	37.93 ± 0.03g	38.13 ± 0.03g	21.82 ± 0.01j	21.95 ±0.01j
M_2	Ca_1	38.20 ± 0.02F	38.42 ± 0.01F	21.85 ± 0.01i	21.98 ± 0.01i
	Ca2	38.22 ± 0.01f	38.44 ± 0.01f	21.87 ± 0.02h	22.0 ± 0.02h
	Ca3	38.26 ±0.03e	38.48 ± 0.04e	21.89 ± 0.02g	22.02 ± 0.02g
M_3	Ca1	38.41 ± 0.02d	38.65 ± 0.02d	21.99 ± 0.02f	21.12 ± 0.02f
	Ca2	38.42 ± 0.01d	38.66 ± 0.01d	22.02 ± 0.02e	22.15 ± 0.01e
	Ca3	38.46 ± 0.02c	38.70 ± 0.02c	22.04 ± 0.02d	22.17 ± 0.02d
M_4	Ca1	38.51 ± 0.02b	38.77 ± 0.02b	22.11 ± 0.05c	22.24 ± 0.05c
	Ca2	38.52 ±0.02b	38.78 ±0.02b	22.19 ± 0.04b	22.32 ± 0.04b
	Ca3	38.57 ± 0.05a	38.83 ± 0.05a	22.21 ±0.03a	22.34 ± 0.03a
Main	$LSD_{0.05}$	0.14	0.015	0.014	0.014
	$LSD_{0.01}$	0.020	0.02	0.021	0.020
Sub-main	$LSD_{0.05}$	0.008	0.009	0.006	0.007
	$LSD_{0.01}$	0.011	0.011	0.009	0.008
Interaction	$LSD_{0.05}$	0.019	0.019	0.014	0.014
	$LSD_{0.01}$	0.026	0.027	0.026	0.027

Notices, M1: without molasses, M2: 140 L ha^{-1}, M3:280 L ha^{-1}, M4 :420Lha^{-1}; Ca1: foliar as tab water without $Ca(NO_3)_2$,Ca2:0.5g L^{-1} and Ca3:1g L^{-1}.

3.4 Yield of Rice

Crop productivity under salt-affected soils may suffer from many problems, which mainly related to the hazard of salinity, sodicity or alkalinity and specific effect of sodium ion. Table 6. Shows the response of rice yields (i.e., straw and grain) to combined effect of different levels from molasses and foliar application $Ca(NO_3)_2$ and the interactions during the two growing seasons. Data showed that yield of rice were significantly increased with increasing dose of molasses application and recorded the highest values with 420Lha^{-1}. The yield of rice were significantly increased with increasing foliar application of $Ca(NO_3)_2$ and recording the highest value up to Ca3 treatment. These results supported by Kondratev et al. (1984) and Tripathy et al. (2017). Table 6 showed that grain and straw yield of rice were significantly increased due to interaction soil application of molasses and foliar of $Ca(NO_3)_2$ as 1g/l. However, the highest values for grain 8907.8 and 9085.96 and 10006.2 and 10136.3 kg $ha^{-1}$for two growing seasons, respectively as shown in Table (6). these results may be to the effect of molasses on the soil is firstly to supply considerable quantities both of potassium, nitrogen, magnesium, phosphate, calcium and some micronutrients particularly in nutrition poor soils hence increasing soil productivity. The substances in molasses allow it to act as a chelator, meaning that it binds with nutrients and makes them easier to absorb. These results supported by Dagar et al. (2019) and Gaafar et al. (2019).

Table 6. Effect of molasses and foliar application of nitrate calcium on grain and straw yield of rice during 2020 and 2021 seasons.

Treatments		Grain (kg ha^{-1})		Straw (kg ha^{-1})	
		2020	2021	2020	2021
M1	Ca1	7220.3±0.92L	7306.86±0.92l	8373.4 ± 1.10l	8470.8 ± 1.20l
	Ca2	7282.8±4.50K	7370.23±4.50k	8434.7± 7.02k	8535.9 ± 7.10k
	Ca3	7326.3±3.05j	7414.23±3.03j	8474.0 ± 5.29j	8575.7 ± 5.30j
M2	Ca1	7491.8±2.62i	7619.16±2.73h	8603.8 ± 4.61i	8750.1 ± 4.71i
	Ca2	7511.0±2.00h	7608.63±2.10i	8622.7 ± 2.31h	8769.3 ± 2.30h
	Ca3	7525.3±5.03g	7623.16±5.13g	8637.7 ± 3.06g	8784.5 ± 3.14g
M3	Ca1	8045.5±6.64f	8166.13±6.74f	9131.1 ± 3.00f	9268.1 ± 3.11f
	Ca2	8055.3±1.50e	8176.066±1.50e	9142.8 ± 2.15e	9279.9 ± 2.27e
	Ca3	8068.3±6.11d	8189.36±6.19d	9154.0 ±4.00d	9291.3 ± 4.00d
M4	Ca1	8834.9±1.10c	8949.83±1.20c	9935.8 ± 2.62c	10064.9 ± 2.73c
	Ca2	8857.4±4.2b	9034.53±4.30b	9956.7 ± 2.83b	10086.2± 2.92b
	Ca3	8907.8±5.68a	9085.96±5.79a	10006.2 ±1.52a	10136.3 ± 1.52a
Main	$LSD_{0.05}$	2.32	2.13	2.36	2.14
	$LSD_{0.01}$	3.37	3.09	3.43	3.11
sub-main	$LSD_{0.05}$	1.34	1.43	1.35	1.46
	$LSD_{0.01}$	1.83	1.96	1.85	1.99
Interaction	$LSD_{0.05}$	3.01	3.21	3.03	3.27
	$LSD_{0.01}$	4.11	4.39	4.13	4.47

Notices, M1: without molasses, M2:140 L ha^{-1}, M3:280 L ha^{-1}**,** M4:420 L ha^{-1}; Ca1: foliar as tab water without $Ca(NO_3)_2$,Ca2:0.5gL^{-1} and Ca3:1g L^{-1}.

3.5. N-uptake of yield of rice

Table (7) showed that N-uptake of grain and straw yield of rice were high significantly increased by increasing application of molasses and recorded highest values with M4.Also the same data pointed out that foliar application of nitrate calcium had high significant effect on increasing of N-uptake of grain and straw yield of rice up to Ca3.on the other hand N-uptake of grain and straw yield of rice was high significantly increased due to the interaction between M x Ca and recorded highest values (129.28 and 47.03 kg ha^{-1}) for grain and straw of rice in the first season and (131.86 and 47.64 kg ha^{-1}) for grain and straw of rice yield in the second season. Data in Table (7) clear that total N-up take yield of rice was high significant increased by application of molasses and recorded highest values due to application of M4. With respect to foliar application of $Ca(No_3)_2$ had high significant effect on increasing of total N-uptake of rice and recorded highest values by Ca_3. The same data showed that N-uptake of rice was highly significant increased due to the interaction between M x Ca and recorded highest values (167.31 and 179.50 kg ha^{-1}) due to the interaction between M4 x Ca3 for 1st and 2nd seasons respectively. These results supported by Schenck (2001), Samavat and Samavat (2014).

Table7. Effect of molasses and foliar application of nitrate calcium on N uptake of grain and straw yield of rice during 2021 and 2022 seasons.

Treatments		2020		2021		Total N-uptake (kg ha^{-1})	
		Grain	Straw	Grain	Straw	2020	2021
M1	Ca1	102.11±0.33l	34.32±0.0l	103.32±0.3l	34.73±0.0l	136.43±0.3l	138.05±0.39l
	Ca2	103.6±0.29k	35.42±0.03k	104.8±0.36k	35.85±0.02k	139.07±0.3k	140.70±0.35k
	Ca3	104.94±0.46j	36.45±0.02j	106.17±0.37j	36.87±0.02j	141.39±0.4j	143.04±0.36j
M2	Ca1	106.58±.53i	37.0±0.02i	108.34±.42i	37.62±0.02i	143.58±0.5i	145.97±0.41i
	Ca2	107.5±0.45h	37.93±0.01h	108.9±0.42h	38.58±0.01h	145.50±0.4h	147.54±0.42h
	Ca3	108.4±0.22g	38.87±0.02g	109.8±0.13g	39.53±0.02g	147.43±0.2g	149.38±0.15g
M3	Ca1	115.1±0.25f	40.17±0.01f	116.8±0.26f	40.77±0.01f	155.30±0.2f	157.63±0.27f
	Ca2	116.0±0.18e	41.14±0.01e	117.8±0.18e	41.76±0.01e	157.22±0.1e	154.57±0.18e
	Ca3	117.0±0.25d	42.11±0.02d	118.8±0.25d	42.74±0.02d	159.18±0.2d	161.57±0.26d
M4	Ca1	127.3±0.35c	44.71±0.02c	128.9±0.26c	45.29±0.01c	172.02±0.3c	174.22±0.26c
	Ca2	128.5±0.15b	45.80±0.02b	131.0±0.15b	46.39±0.01b	174.32±0.1b	177.48±0.15b
	Ca3	129.2±0.12a	47.03±0.0a	131.8±0.13a	47.64±0.0a	176.31±0.1a	179.50±0.13a
Main	$LSD_{0.05}$	0.12	0.008	0.108	0.009	0.123	0.108
	$LSD_{0.01}$	0.17	0.012	0.157	0.013	0.180	0.157
Sub-main	$LSD_{0.05}$	0.14	0.010	0.143	0.008	0.138	0.144
	$LSD_{0.01}$	0.23	0.017	0.238	0.013	0.230	0.238
Interaction	$LSD_{0.05}$	0.28	0.011	0.265	0.012	0.281	0.261
	$LSD_{0.01}$	0.31	0.021	0.321	0.021	0.374	0.371

Notices, M1: without molasses, M2: 140 L ha^{-1}, M3:280 L ha^{-1}, M4 :420 L ha^{-1}; Ca1: foliar as tab water without $Ca(NO_3)_2$,Ca2:0.5 g L^{-1} and Ca3:1 g L^{-1}.

4. Conclusion

Our results were in line with the postulated hypothesis as application of 420 L ha^{-1} from molasses and foliar application of $Ca(NO_3)_2$ as 1 g L^{-1} outperformed other treatments in terms of improved bulk density, soil porosity, soil fertility and yield of rice plants. Furthermore, rice grain yield and higher yield qualities under a salty environment continued to favour foliage treated with $Ca(NO_3)_2$. Therefore, these findings may serve as base line to reducing the adverse effects of salinity on rice crop and enhancing the physical and fertility of the soil.

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