Egypt. J. of Appl. Sci., 37 (9-10) 2022 *82-105*

AN ATTEMPT TO INCREASE THE AMOUNT OF OIL IN CORN GROWN UNDER SALINE SOILS BY USING DIFFERENT FERTILIZATION TREATMENTS

El-Labban, A.A. [1*] ; S.A. Aboelgoud [2] and I.S.M. Mosaad [3]

[1] Oils and Fats Research Department - Food Technology Research Institute - Agricultural Research Centre, Giza 12619, Egypt.

[2] Forage Research Department - Field Crops Research Institute - Agricultural Research centre, Giza 12619, Egypt.

[3] Soil Fertility and Plant Nutrition Research Department - Soil, Water and Environment Research Institute - Agricultural Research Centre, Giza 12619, Egypt

***E-mail: drahmedellabban1963@gmail.com[*]**

ABSTRACT

The main objective of this study was to use different fertilization methods and rates to increase the amount of oil in maize per unit area to contribute to filling part of the gap in edible oils. Two field experiments were conducted, at El-Serw Agriculture Research Station, Agriculture Research Centre, Damietta Governorate, to demonstrate the effect of two methods of phosphorous fertilization (foliar and soil applied) & five nitrogen fertilization rates (0, 95, 190, 286 and 381 kg N ha^{-1}) & their interaction on grain, stover yields and some chemical composition of maize in 2020 & 2021 seasons. The obtained results indicated that use of phosphorous foliar fertilization increased grain and stover yields by 41.2 and 38.07%, respectively. As well as, grain protein and oil yields were increased by 54.89 and 80.6% respectively. It also showed that applying 381 kg N ha^{-1} increased grain & stover yields by 251.28 and 197.34%, respectively. As well as protein and oil yields were increased by 621.15 and 322.07%, respectively, as compared to control without apply phosphate or nitrogen fertilizer. These treatments gave good results in increasing the amount of oil per unit area, which was the main purpose of the research. While maximizing the use of saline soil for this purpose. The foliar phosphorous treatment also led to an increase in the efficiency of nitrogen utilization with all nitrogen fertilization rates. Thus, utilizing huge regions with a high salinity of soil and irrigation water in the cultivation of an economic crop such as maize to produce grains and oil contribute to filling part of the gap in edible oils, as well as stover to manufacture silage for animal feeding.

Key Words: Maize, nitrogen, phosphorus, foliar spray, salt stress, fertilization efficiencies, oil quantity.

INTRODUCTION

There is ample research shows that nutrients enter the above-ground portion of plants (usually the leaves) and supply at least part of their nutritional requirements. Several reports of micronutrient deficiencies being alleviated with foliar sprays encouraged such an approach with nitrogen, phosphorus and potassium. Although some yield increases were achieved, in most cases the greater total nutrient requirement of macronutrients and problems with leaf injury when rates were raised to the needed levels made foliar application impractical. Some soils exhibit characteristics such as low or high pH, the presence of poorly available minerals, or have been subjected to nutrient-depleting processes (erosion, leaching, etc.) **(Rengel, 2015)**. As a result, nutrient deficiency has become a worldwide problem **(Fageria *et al.,* 2008)**. In addition, mineral P resources will be depleted in the near future, posing an even greater problem in agriculture **(Raboy, 2013)**. Excessive P fertilization, on the other hand, is undesirable because P is a limited, nonrenewable resource **(Schoumans *et al.,* 2015 and Mew 2016)**, and diffuse P losses from overly fertilized fields are a major cause of eutrophication in surface waters **(Buczko and Kuchenbuch 2007)**. Also, the efficiency of absorption of nutrients such as nitrogen and phosphorous decreases in saline soils.

Maize (*Zea mays* L.), a C4 metabolism plant, is a major grain crop that provides basic food and/or oil for humans and cattle around the world. Maize is typically salt-tolerant and characterized as moderately sensitive to salinity, with germination and seedling establishment being more sensitive to saltwater than later developmental phases **(Katerji *et al.,* 1994)**. Plant uptake of nitrogen (N), potassium (K), calcium (Ca), magnesium (Mg), and iron (Fe) is reduced by high rhizosphere sodium (Na) and chlorine (Cl). Low grain production in maize under salt stress is due to reduced grain weight and quantity **(Farooq *et al.,* 2015)**. Salinity is a major issue that has a significant impact on maize production **(Qayyum *et al.,* 2016)**. When the soil salinity increased from 3.8 to 7.4 dS m1 in the third crop rotation year, maize grain yield decreased by 34% **(Cucci *et al.,* 2019)**. Furthermore, an increase in the salt of irrigation water has a negative impact on plants, particularly maize. The use of salt-water to irrigate maize resulted in lower yields **(Feng *et al.,* 2017 and Huang *et al.,* 2019)**.

Nitrogen (N) is a key nutrient for crop production that is commonly supplied in significant amounts to soils **(Singh *et al.,* 2007 and Wei-Dong *et al.,* 2008)**. Mineral nitrogen fertilization improves growth, biomass, and yield, as well as facilitates metabolism, resulting in higher protein content in maize plant tissue **(Lucas *et al.,* 2019 and Mosaad *et al.,* 2020)**. Nitrogen has a direct impact on protein amino acid composition and, as a result, the nutritional quality of economic production. Excessive salt harms plants by interfering with the uptake of competing nutrients and disrupting the uptake of water into the roots **(David, 2007)**. Ammonification was slowed as salinity levels increased, but it was not fully stopped. Because nitrification was inhibited by both the amount of salt and the type of amendment supplied to the soil, the amount of mineral N that accumulated was generally lowered as salinity increased **(Zeng *et al.*, 2016)**.

Therefore, it is necessary to search for other methods of phosphate fertilization that promote and maintain an adequate supply of the plant's nutrients. One of the most important ways to add nutrients to plants is foliar spraying. The advantage of foliar phosphorus spraying over in-soil application is that because leaf tissue has the same morphological structure as root tissue (it both originate from the meristem tissue), plants can rapidly absorb dissolved minerals **(Martinka *et al.*, 2014)**. Foliar fertilizing can thus successfully manage soil deficiency in micro-elements **(Barbosa *et al.*, 2013 and Tejada *et al.*, 2018)**.

The present study was carried out in the northern Delta of Egypt to see how phosphorous addition methods affected nitrogen fertilization efficiency, grain production, and oil quality characteristics of maize under salt stress. The hypotheses were that: (i) maize requires more fertilizer N and P for maximum yield than the recommended rate, (ii) this quantity rises as soil salinity and pH rise, and (iii) changing the traditional method of fertilizing with one of the two components has a greater effect on the economic maize crop and oil under salinity stress.

MATERIAL AND METHODS

Description of the experimental site and climate

At El-Serw Agriculture Research Station, Agriculture Research Centre, Damietta Governorate (31° 14 'N and 31° 48 'E) in northern Egypt, field experiments were conducted on clayey soil for two summer seasons (2020 and 2021). At the start of the experiments, the analyses of the surface soil layer (0 to 30 cm) were as follows: soil saturation extract for EC analysis (ECe) 8.77 dS m^{-1} with pH (H_2O, 1 soil to 2.5 H_2O) value of 8.2 and contained 6.1 g kg^{-1} walkley-black carbon, 0.30 g kg^{-1} total nitrogen by the Kjeldahl method **(Nelson and Sommers 1980)**, 7.93 mg kg^{-1} 0.5 M $NaHCO_3$-extractable P **(Olsen *et al.*, 1954)** and 422 mg kg^{-1} 1 N NH_4OAc-extractable K **(Jackson, 2005)**. The soil study experiment was classified as moderately saline soil (ECe 8-16 dS/m) based on the USDA classes **(Richards, 1954)**. The experimental farm was irrigated from the El-Serw drainage, irrigated from a point at the beginning of the drainage was approximately 20 km (EC 3.2:3.3 dS m-1, SAR 10.5:11.3), so the irrigation water classification is considered to be water which increases salinity problems **(Tagour and Mosaad 2017 ; Mosaad *et al.*, 2020)**. The area has an arid climate with dry hot summer and wet cool winter according to the Köppen climate classification **(Messina, 2019)**. Meteorological conditions (mean Precipitation (mm), Surface Pressure (kPa), Relative Humidity (%) and Wind Speed (m s^{-1}) (Table 1), and maximum, minimum, and main Temperature, dew/forest point, Wet Bulb and Earth Skin Temperature (°C) at the maize cultivation experimental site during the two summer seasons (Fig. 1).

Table 1. Average Precipitation Corrected (mm), Surface Pressure (kPa), Relative Humidity (%) and Wind Speed Range (m s^{-1}) of experimental site during summer seasons 2020 and 2021.

Month	Precipitation Corrected (mm)		Surface Pressure (kPa)		Relative Humidity (%)		Wind Speed Range (m s^{-1})	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
2020								
May	0.01	0.02	101.30	0.31	60.15	6.40	3.15	0.95
June	0.00	0.01	100.99	0.23	49.90	5.89	3.34	0.77
July	0.00	0.00	100.60	0.18	51.85	3.16	3.15	0.55
August	0.00	0.00	100.62	0.14	53.80	2.94	3.04	0.50
September	0.00	0.00	101.01	0.25	58.18	4.06	2.93	0.52
October	0.04	0.11	101.43	0.18	61.33	2.72	2.72	0.41
2021								
May	0.00	0.00	101.15	0.17	47.44	6.04	3.07	0.69
June	0.00	0.00	101.14	0.26	49.66	3.36	3.20	0.50
July	0.00	0.00	100.63	0.18	50.15	3.53	3.15	0.79
August	0.03	0.06	100.73	0.18	51.94	4.77	2.70	0.62
September	0.05	0.11	101.09	0.18	55.27	3.79	3.26	0.49
October	0.18	0.61	101.47	0.28	59.66	4.16	2.89	0.54

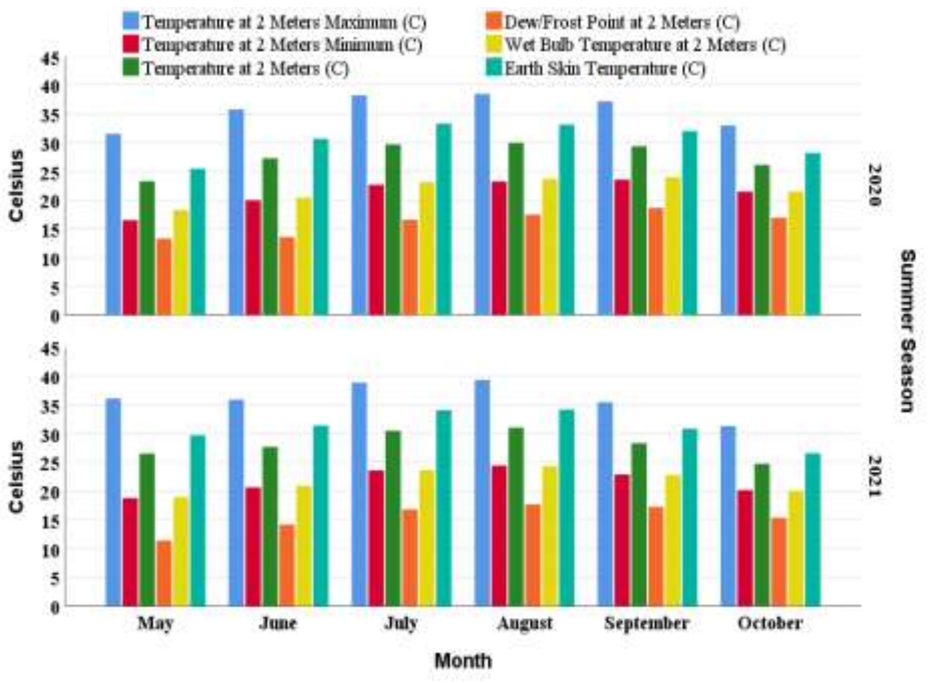

Fig. 1. Maximum, Minimum and Main Temperature, Dew/Forest Point, Wet Bulb and Earth Skin Temperature (°C) of experimental site during summer seasons 2020 and 2021.

Experimental treatments and crop management

A split-plot design with four replicates were used where the main plots were arranged to study the effect of phosphorous addition methods to evaluate the foliar and -soil P applied. Foliar phosphorus was applied at 144 mM KH_2PO_4 at a rate of 460 L ha^{-1} **(Rafiullah *et al.*, 2018 & 2020)** and, it was sprayed at the knee-height (Zadocs-32) + tasseling (Zadocs-65) stage to maize. While the soil addition of phosphorus was applied at the recommended rate of 36 kg P ha^{-1} as Triple Calcium Super Phosphate (16.4% P) before maize cultivation. Mineral nitrogen fertilization rates were 0, 95, 190, 286 and 381 kg N ha^{-1} as ammonium nitrate (33.5% N) occupied in the subplots. The plot was 16 m^2 (4m × 4m) in size and had four ridges (4m long and 50 cm apart). On May 3rd, maize (*Zea mays* L.), variety, single cross 30K8, was sown at 28.6 kg grain ha^{-1}. In both seasons, maize grains were planted on 25 cm apart at one side with two kernels and hand-planted per hill and thinned to one plant per hill before the first irrigation. Other agricultural practices recommended for the region were carried out.

Maize characteristics and crop yields

Maize was harvested at physiological maturity on October 5th in both seasons. For yield measurement, a net plot area of 4m ×4m was harvested manually and grains from the ears were manually removed. Grain and stover yields of maize were reported at 14% moisture content and on an oven-dry weight basis.

Plant and grain analysis

Sub-samples of maize grain and stover were oven-dried at 65 ˚C for 48 h to a constant weight and ground to pass through a 0.5mm screen. Total N content was determined by Micro-Kjeldahl method **(Westerman 1991)**.

Grain protein content was estimated by multiplying N (%) in maize grains × 5.65.

Oil percentage in the grains were determined by extracting using a Soxhlet apparatus according to the method described by **AOAC, (2005)**.

Nitrogen use efficiencies agronomic efficiency (AE) (kg grain/kg N applied), physiological efficiency (PE) (kg grain/kg N uptake) and apparent recovery efficiency (RE) (%) of added fertilizer N were calculated as:

AE = (grain yield in N fertilized plot–grain yield in no N plot) / (quantity of N fertilizer applied in N fertilized plot)

PE = (grain yield in N fertilized plot–grain yield in no N plot) / (total N uptake in N fertilized plot–total N uptake in no N plot)

RE (%) = [(total N uptake in N fertilized plot–total N uptake in no N plot) / (quantity of N fertilizer applied in N fertilized plot)] × 100

The statistical analysis

Data were collected for statistical analysis according to **(Snedecor and Cochran 1989)**. Mean values were compared, at a level of $P < 0.05$ by using the Least Significance Difference (LSD) test. CoStat (v. 6.400 CoHort software, California, USA) and SPSS (v. 26, IBM Inc., Chicago, II, USA) were used for statistical analysis for data.

RESULTS AND DISCUSSION

Maize grain and stover yield:

The maize grain and stover were affected by phosphorus fertilization method & nitrogen fertilization rates factors & their interaction in 2020 & 2021 summer seasons and their pooled analysis (Table 2 and Figs 2 &3). Data in Table 2 showed that the effect of the phosphorus fertilization method and nitrogen fertilization rates and their interaction were significantly (P<0.01) on maize grain yield in both seasons and the pooled analysis. While, the effect of phosphorus fertilization method was significant (P<0.05) on maize stover yield in the first season and the pooled analysis. The influence of nitrogen fertilization rates and the interaction effect were significant (P<0.01) on maize stover yield in the second season and the pooled analysis. As for the factor of phosphorous fertilization methods, the highest results of the grain and stover yields were obtained with the application of phosphorus fertilization by foliar, followed by ground phosphorous fertilization. The grain yield of maize in the pooled analysis increased due to foliar phosphorus fertilization and soil phosphorus fertilization compared to without phosphorus by 41.2 and 18.08%, respectively. While, stover yield increased due to foliar phosphorus fertilization and soil phosphorus fertilization compared to without phosphorus by 38.07 and 13.66%, respectively. On the other hand, the use of 318 kg ha^{-1} followed by 286, 190 and 95 kg N ha^{-1}, respectively gave the highest yields of maize grain and stover compared to the control treatment without nitrogen fertilization by (251.28 and 197.34%), (225.21 and 186.97%), (187.81 and 183.04%) and (101.69 and 98.20%), respectively. The interaction effect on maize grain yield (Fig 2) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (286 kg N ha^{-1} + foliar phosphorus) with a significant difference. The following increase was at (286 kg N ha^{-1} + soil phosphorus) followed by (190 kg N ha^{-1} + foliar phosphorus) with no significant difference. While, the interaction effect on maize stover yield (Fig 3) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus), (286 kg N ha^{-1} + foliar phosphorus) and (190 kg N ha^{-1} + foliar phosphorus), respectively with no significant differences.

One of the major challenges is the fixation of phosphatic fertilizers in alkaline soils, it causes phosphorus nutritional stress, which can reduce maize yield **(Rafiullah *et al.*, 2020)**. In the pooled analysis, foliar phosphorus fertilization and soil phosphorus fertilization increased maize grain yield by 41.2 and 18.08 %, respectively, when compared to no phosphorus fertilization.

While foliar and soil phosphorus fertilization increased stover yield by 38.07 and 13.66 %, respectively, when compared to no phosphorus fertilization. Phosphorus increases plant growth development by taking part in the metabolic activity, enhanced photosynthetic process and photosynthate assimilation **(Wahid *et al.*, 2019)**. These results are similar to those attributed by **Rafiullah *et al.*, (2020)**, who found that foliar spray of phosphorus significantly enhanced grains yield of maize where phosphorus was applied as banding or broadcast at the time of sowing.

Table 2: Means of maize grain and stover yield (t ha-1) as affected by phosphorous addition methods and nitrogen fertilization rates in 2020 & 2021 summer seasons.

Treatment	Grain yield (t ha^{-1})			Stover yield (t ha^{-1})		
	1st	2nd	Pooled analysis	1st	2nd	Pooled analysis
Phosphorus fertilization Method						
Without P	5.079	5.153	5.116	8.599	8.004	8.301
S. P	6.025	6.057	6.041	9.359	9.511	9.435
F. P	7.192	7.256	7.224	11.356	11.565	11.461
Total	6.099	6.155	6.127	9.771	9.694	9.732
p value	0.020	0.000	0.006	0.039	0.004	0.013
Nitrogen fertilization rates (kg N ha^{-1})						
Without N	2.393	2.447	2.420	4.119	4.230	4.175
95.00	4.882	4.880	4.881	8.230	8.320	8.275
190.00	6.883	7.046	6.965	12.332	11.303	11.817
286.00	7.852	7.888	7.870	11.834	12.127	11.981
381.00	8.485	8.516	8.501	12.340	12.489	12.414
Total	6.099	6.155	6.127	9.771	9.694	9.732
p value	0.000	0.000	0.000	0.000	0.000	0.000
P.M. × N						
p value	0.000	0.000	0.000	0.000	0.000	0.000

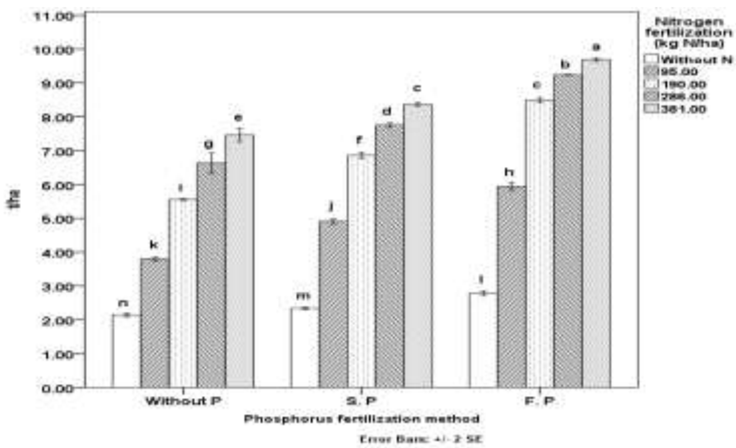

Fig. 2. Pooled analysis of maize grain yield (t ha^{-1}) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

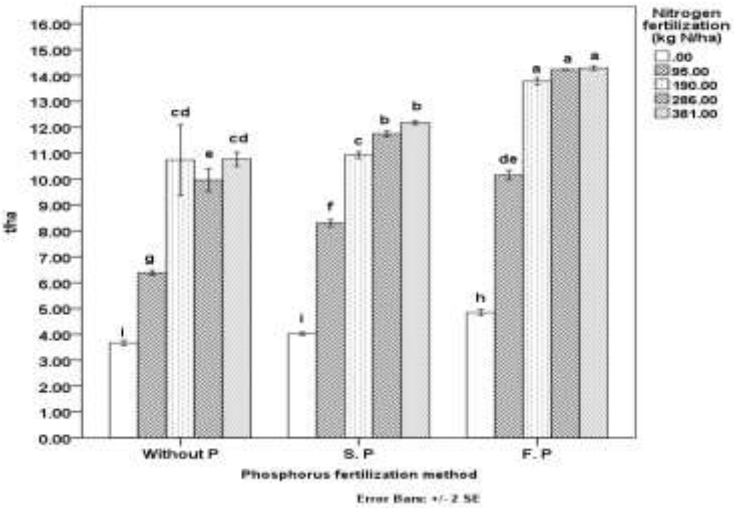

Fig. 3. Pooled analysis of maize stover yield (t ha^{-1}) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

On the other hand, the rate of nitrogen application is an important management decision for maize (*Zea mays* L.) production **(Davies *et al.,* 2020)**. The use of 318 kg ha^{-1} followed by 286, 190 and 95 kg N ha^{-1}, respectively gave the highest yields of maize grain and stover compared to the control treatment without nitrogen fertilization by (251.28 and 197.34%), (225.21 and 186.97%), (187.81 and 183.04%) and (101.69 and 98.20%), respectively.

While the interaction effect on maize grain yield (Fig. 2) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (286 kg N ha^{-1} + foliar phosphorus) with a significant difference. The following increase was at (286 kg N ha^{-1} + soil phosphorus) followed by (190 kg N ha^{-1} + foliar phosphorus) with no significant difference. While, the interaction effect on maize stover yield (Fig. 3) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus), (286 kg N ha^{-1} + foliar phosphorus) and (190 kg N ha^{-1} + foliar phosphorus), respectively with no significant differences. Commercial fertilizers, particularly phosphorus and nitrogen fertilizers, are responsible for at least 30–50% of crop output in intensive cultivation of high-yielding crop varieties **(Stewart *et al.,* 2005)**. This increase in the yield of corn grain and straw is due to the direct and indirect effect of nitrogen **(Blumenthal *et al.,* 2008 and Mosaad *et al.,* 2020)** & phosphorous **(Zhang *et al.,* 2018 and Wahid *et al.,* 2019)** on vegetative growth, such as an increase in leaf area and the positive effect on photosynthetic pigments, which results in an increase in yield.

Chemical composition of maize grain

Chemical composition of maize grain such as protein and oil percentage for phosphorus fertilization method and nitrogen fertilization rates factors and their interaction in 2020 & 2021 summer seasons and their pooled analysis is shown in Table 3 and Figs 4 & 5. Data in Table 3 showed that the effect of phosphorus fertilization method and nitrogen fertilization rates and their interaction were significantly (P<0.01) on maize grain content of protein and oil in both seasons and the pooled analysis. As for the factor of phosphorous fertilization methods, the highest results of protein and oil percentage in maize grain were obtained with the application of phosphorus fertilization by foliar, followed by soil phosphorous fertilization. On the other hand, the use of 318 kg N ha^{-1} followed by 286, 190 and 95 kg N ha^{-1}, respectively gave the highest values of maize protein and oil percentage compared to the control treatment without nitrogen fertilization. The interaction effect on maize grain protein percentage (Fig. 4) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (381 kg N ha^{-1} + soil phosphorus), (286 kg N ha^{-1} + foliar phosphorus) and (381 kg N ha^{-1} + without phosphorus), respectively with a significant difference. While, the interaction effect on maize grain oil percentage (Fig 5) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus), (286 kg N ha^{-1} + foliar phosphorus) and (190 kg N ha^{-1} + foliar phosphorus), respectively with a significant difference. Also, it is noticed in Figure 5 that there are no significant differences between the effect of (381 kg N ha^{-1} + soil phosphorus) and (95 kg N ha^{-1} + foliar phosphorus) on the oil content of maize grains.

Table 3: Means of maize grain protein and oil percentage (%) as affected by phosphorous addition methods and nitrogen fertilization rates in 2020 & 2021 summer seasons.

Treatment	Grain protein %			Grain oil %		
	1st	2nd	Pooled analysis	1st	2nd	Pooled analysis
Phosphorus fertilization Method						
Without P	6.869	7.221	7.045	8.329	8.036	8.183
S. P	7.119	7.356	7.237	9.131	9.059	9.095
F. P	7.544	7.849	7.697	10.708	10.455	10.582
Total	7.177	7.475	7.326	9.389	9.183	9.286
p value	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen fertilization rates (kg N ha^{-1})						
Without N	4.663	4.831	4.747	8.709	8.458	8.584
95.00	5.872	6.120	5.996	8.894	8.708	8.801
190.00	7.263	7.570	7.416	9.150	9.098	9.124
286.00	8.598	8.961	8.779	9.758	9.441	9.600
381.00	9.491	9.893	9.692	10.434	10.211	10.323
Total	7.177	7.475	7.326	9.389	9.183	9.286
p value	0.000	0.000	0.000	0.000	0.000	0.000
P.M. × N						
p value	0.000	0.000	0.000	0.000	0.000	0.000

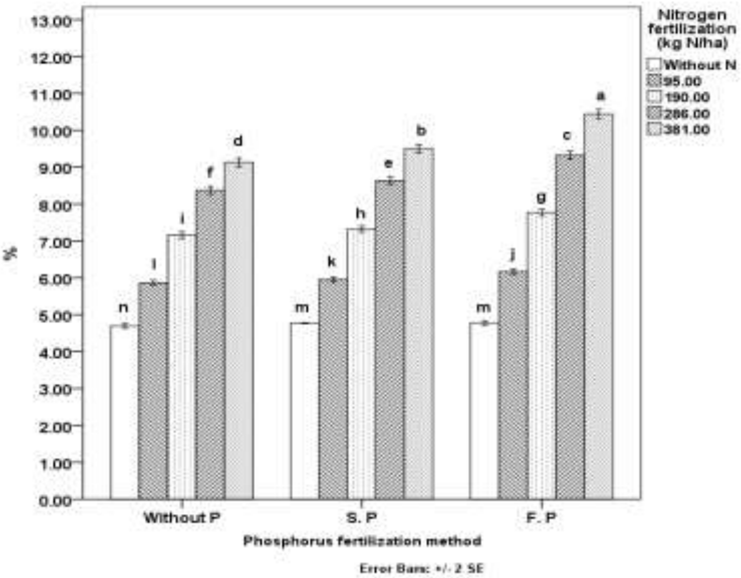

Fig. 4. Pooled analysis of maize grain protein% affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

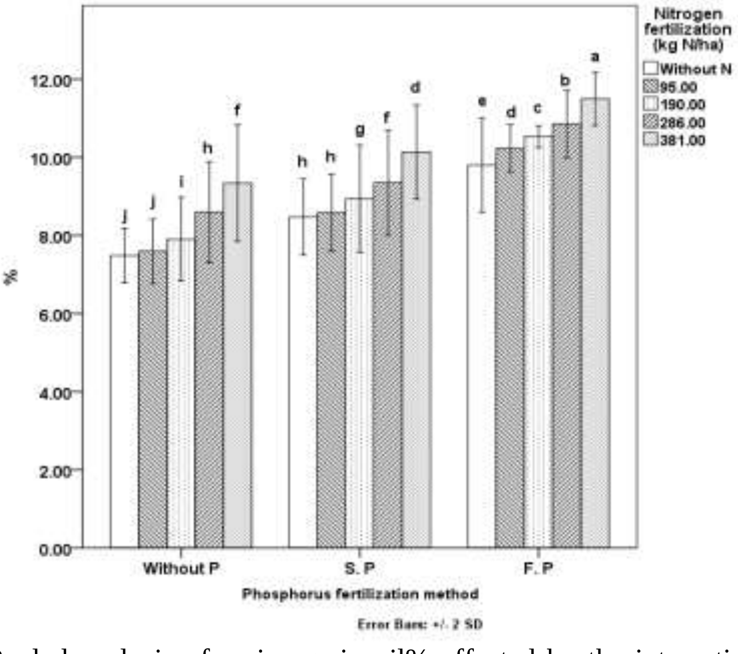

Fig. 5. Pooled analysis of maize grain oil% affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

Chemical composition yield (kg ha^{-1}) of maize

Chemical composition yield of maize such as protein and oil yield (kg ha^{-1}) for phosphorus fertilization method and nitrogen fertilization rates factors and their interaction in 2020 & 2021 summer seasons and their pooled analysis is shown in Table 4 and Figs 6 & 7. Data in Table 4 showed that the effect of phosphorus fertilization method and nitrogen fertilization rates and their interaction were significantly (P<0.01) on maize protein and oil yield (kg ha^{-1}) in both seasons and the pooled analysis. As for the factor of phosphorous fertilization methods, the highest results of the maize protein and oil yield were obtained with the application of phosphorus fertilization by foliar, followed by soil phosphorous fertilization. The protein yield of maize in the pooled analysis increased due to foliar phosphorus fertilization and soil phosphorus fertilization compared to without phosphorus by 54.89 and 21.1%, respectively. While, oil yield increased due to foliar phosphorus fertilization and soil phosphorus fertilization compared to without phosphorus by 80.6 and 30.2%, respectively. On the other hand, the use of 318 kg ha^{-1} followed by 286, 190 and 95 kg N ha^{-1}, respectively gave the highest yields of maize protein and oil compared to the control treatment without nitrogen fertilization by (621.15 and 322.07%), (504.99 and 264.39%), (352.05 and 208.93%) and (155.54 and 109.21%), respectively.

Table 4: Means of maize grain protein and oil yield (t ha-1) as affected by phosphorous addition methods and nitrogen fertilization rates in 2020 & 2021 summer seasons.

Treatment	Grain protein yield (kg ha^{-1})			Grain oil yield (kg ha^{-1})		
	1st	2nd	Pooled analysis	1st	2nd	Pooled analysis
Phosphorus fertilization Method						
Without P	379.00	403.70	391.30	434.55	426.80	430.65
S. P	464.80	483.00	473.85	563.65	557.90	560.70
F. P	591.45	620.90	606.10	781.75	773.80	777.75
Total	478.42	502.53	490.42	593.32	586.17	589.70
p value	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen fertilization rates (kg N ha^{-1})						
Without N	111.67	118.17	114.92	210.83	209.08	209.92
95.00	287.67	299.58	293.67	443.50	434.67	439.17
190.00	503.08	536.33	519.50	642.75	654.25	648.50
286.00	679.33	711.17	695.25	775.67	754.50	764.92
381.00	810.33	847.42	828.75	893.83	878.33	886.00
Total	478.42	502.53	490.42	593.32	586.17	589.70
p value	0.00	0.00	0.00	0.00	0.00	0.00
P.M. × N						
p value	0.00	0.00	0.00	0.00	0.00	0.00

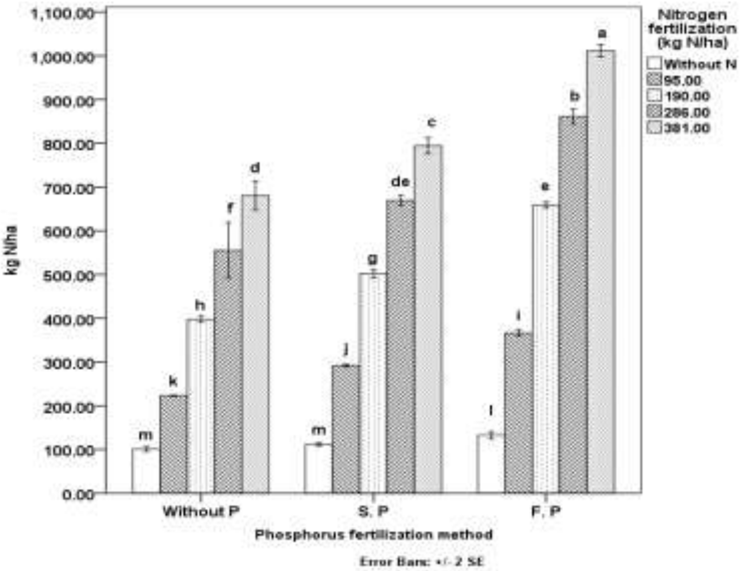

Fig. 6. Pooled analysis of maize grain protein yield (kg ha^{-1}) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

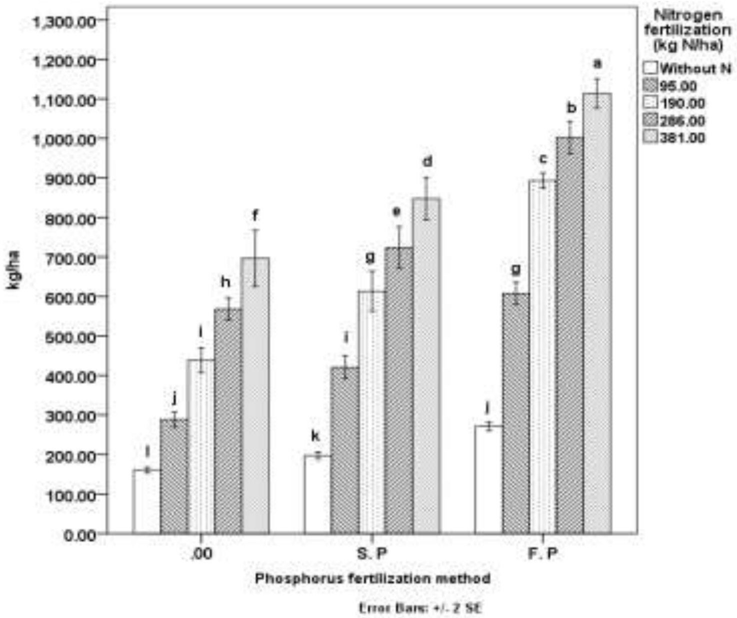

Fig. 7. Pooled analysis of maize grain oil yield (kg ha^{-1}) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

The interaction effect on maize protein yield (Fig 6) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (286 kg N ha^{-1} + foliar phosphorus), (381 kg N ha^{-1} + soil phosphorus) and (381 kg N ha^{-1} + without phosphorus), respectively with a significant difference. Also, it is noticed in Figure 6 that there are no significant differences between the effect of (381 kg N ha^{-1} + without phosphorus) and (286 kg N ha^{-1} + soil phosphorus) and between (286 kg N ha^{-1} + soil phosphorus) and (190 kg N ha^{-1} + foliar phosphorus) on the protein yield of maize.

While, the interaction effect on maize grain oil yield (Fig 7) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (286 kg N ha^{-1} + foliar phosphorus), (190 kg N ha^{-1} + foliar phosphorus) and (381 kg N ha^{-1} + soil phosphorus), respectively with a significant difference.

An adequate supply of nitrogen and phosphate fertilizers for maize plants is one of the determining factors for raising the protein and oil content of maize grains. In terms of phosphorus fertilization methods, the current research found that foliar phosphorus fertilization had the best outcomes in terms of protein and oil % in maize grain, followed by soil phosphorous fertilization. So, the protein yield of maize in the pooled analysis increased due to foliar phosphorus fertilization and soil phosphorus fertilization compared to without phosphorus by 54.89 and 21.1%, respectively. When compared to the control treatment without nitrogen fertilization, the application of 318 kg N ha-1, followed by 286, 190, and 95 kg N ha^{-1}, yielded the highest values of maize protein and oil percentage, respectively, where it gave the highest yields of maize protein and oil compared to the control treatment without nitrogen fertilization by (621.15 and 322.07%), (504.99 and 264.39%), (352.05 and 208.93%) and (155.54 and 109.21%), respectively. The interaction effect on maize grain protein percentage revealed that the highest values were obtained with (381 kg N ha-1 + foliar phosphorus), followed by (381 kg N ha-1 + soil phosphorus), (286 kg N ha-1 + foliar phosphorus), and (381 kg N ha-1 + without phosphorus) with a significant difference. While the interaction effect on maize grain oil percentage revealed significant differences with (381 kg N ha-1 + foliar phosphorus), (286 kg N ha-1 + foliar phosphorus), and (190 kg N ha-1 + foliar phosphorus). Furthermore, no significant differences in the effect of (381 kg N ha-1 + soil phosphorus) and (95 kg N ha-1 + foliar phosphorus) on the oil content of maize grains are observed. Higher biomass yields & protein yields and concentrations in plant tissue are often raised when nitrogen fertilizer is applied, because the amino acid composition of protein, and thus its nutritional quality, is frequently influenced by nitrogen **(Blumenthal *et al.*, 2008)**. Also, the content of maize grains of protein and oil increased when using 125% of the recommended rate of mineral fertilizers such as nitrogen and phosphorous **(Ray *et al.,* 2019)**. Therefore, these increases in the protein and oil content of corn kernels are due to the adequate supply of nitrogen and phosphate fertilizers. The superiority of foliar fertilization of phosphorous is due to its superiority in the rapid supply of phosphorous than the soil fertilization, which causes soil properties to stabilize phosphorous before the plant can benefit from it **(Fageria *et al.,* 2009, Rafiullah *et al.,* 2018)**.

Nitrogen uptake of maize (kg N ha^{-1})

Impact of phosphorus fertilization method & nitrogen fertilization rates factors and their interaction in 2020 & 2021 summer seasons and their pooled analysis on nitrogen uptake in maize grain, stover and total, are shown in Table 5 and Figs 8, 9 and 10. Data in Table 5 showed that the effect of phosphorus fertilization method and nitrogen fertilization rates and their interaction were significantly ($P<0.01$) on nitrogen uptake in maize grain, stover and total in both seasons and pooled analysis. As for the factor of phosphorous fertilization methods, the highest results of nitrogen uptake in maize grain, stover and the total obtained with application of phosphorus fertilization by foliar, followed by ground phosphorous fertilization. On the other hand, the highest nitrogen uptake in maize grain, stover and total values were obtained with 318 kg ha^{-1} followed by 286, 190 and 95 kg N ha^{-1}, respectively.

The interaction effect on nitrogen uptake in maize grain (Fig. 8) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (286 kg N ha^{-1} + foliar phosphorus), (381 kg N ha^{-1} + soil phosphorus) and (381 kg N ha^{-1} + without phosphorus), respectively with a significant difference. Also, it is noticed in Figure 8 that there are no significant differences between the effect of (381 kg N ha^{-1} + without phosphorus) and (286 kg N ha^{-1} + soil phosphorus) and between (286 kg N ha^{-1} + soil phosphorus) and (190 kg N ha^{-1} + foliar phosphorus) on the nitrogen uptake in maize grain.

While, the interaction effect on nitrogen uptake in maize stover (Fig. 9) showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (286 kg N ha^{-1} + foliar phosphorus), (381 kg N ha^{-1} + soil phosphorus) and (286 kg N ha^{-1} + foliar phosphorus), respectively with a significant difference. Also, in Figure 9, it is noticed that there are no significant differences between the effect of (381 kg N ha^{-1} + without phosphorus) and (190 kg N ha^{-1} + foliar phosphorus) on the nitrogen uptake in maize stover.

Total nitrogen uptake of maize (kg N ha^{-1}) as affected by the interaction between phosphorus fertilization methods and nitrogen fertilization rates is shown in Fig 10. It showed that the highest values obtained with (381 kg N ha^{-1} + foliar phosphorus) followed by (286 kg N ha^{-}

[1] + foliar phosphorus) and (381 kg N ha^{-1} + soil phosphorus), respectively with a significant difference. Also, it is noticed in Figure 10 that there are no significant differences between the effect of (381 kg N ha^{-1} + without phosphorus) and (286 kg N ha^{-1} + soil phosphorus) and between (286 kg N ha^{-1} + soil phosphorus) and (190 kg N ha^{-1} + foliar phosphorus) on the total nitrogen uptake of maize.

Table 5: Means of maize grain and stover nitrogen uptake and total (kg N ha^{-1}) as affected by phosphorous addition methods and nitrogen fertilization rates in 2020 & 2021 summer seasons.

Treatment	Grain N-Uptake (kg N ha-1)			Stover N-Uptake (kg N ha-1)			Total N-Uptake (kg N ha-1)		
	1st	2nd	Pooled analysis	1st	2nd	Pooled analysis	1st	2nd	Pooled analysis
Phosphorus fertilization Method									
Without P	60.65	64.59	62.62	57.42	54.56	55.99	118.07	119.15	118.61
S. P	74.36	77.28	75.82	62.60	65.18	63.89	136.95	142.47	139.71
F. P	94.63	99.34	96.99	76.00	79.16	77.58	170.63	178.50	174.57
Total	76.55	80.41	78.48	65.34	66.30	65.82	141.89	146.71	144.30
p value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen fertilization rates (kg N ha^{-1})									
Without N	17.87	18.92	18.40	9.64	10.12	9.88	27.51	29.04	28.28
95.00	46.03	47.94	46.99	47.55	49.22	48.39	93.58	97.16	95.37
190.00	80.48	85.81	83.14	78.50	73.03	75.76	158.98	158.84	158.91
286.00	108.70	113.77	111.24	91.37	95.87	93.62	200.07	209.64	204.86
381.00	129.65	135.59	132.62	99.64	103.27	101.45	229.28	238.86	234.07
Total	76.55	80.41	78.48	65.34	66.30	65.82	141.89	146.71	144.30
p value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P.M. × N									
p value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

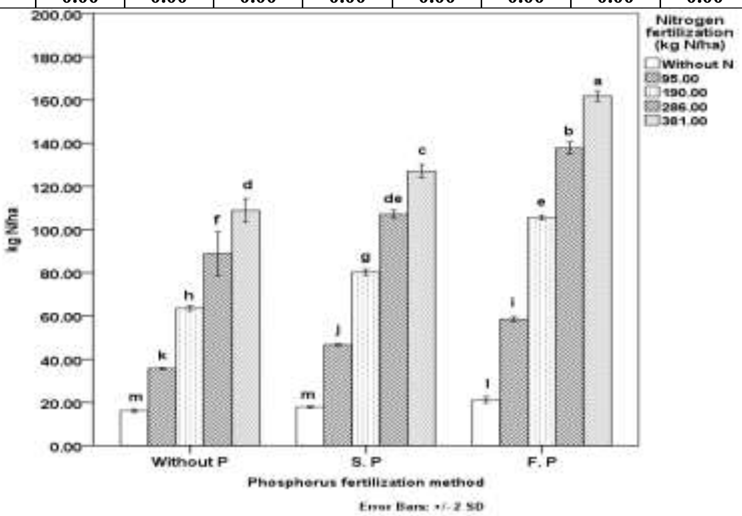

Fig. 8. Pooled analysis of maize grain nitrogen uptake (kg N ha^{-1}) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

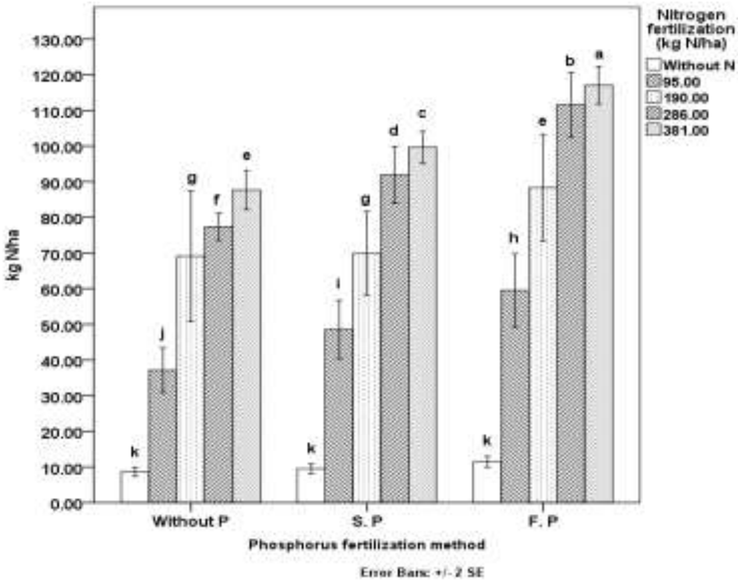

Fig. 9. Pooled analysis of maize stover nitrogen uptake (kg N ha^{-1}) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

To explain the effect of phosphorous addition methods and nitrogen fertilization rates on total nitrogen uptake in maize, (Fig 10). Total nitrogen uptake of maize (kg N ha-1) was significantly affected by the interaction between phosphorus fertilization methods and nitrogen fertilization rates, with the highest values obtained with (381 kg N ha-1 + foliar phosphorus), followed by (286 kg N ha-1 + foliar phosphorus) and (381 kg N ha-1 + soil phosphorus), respectively. There were no significant differences in total nitrogen uptake of maize between (381 kg N ha-1 + without phosphorus) and (286 kg N ha-1 + soil phosphorus) and between (286 kg N ha-1 + soil phosphorus) and (190 kg N ha-1 + foliar phosphorus). Thus, it is clear that the foliar treatment with phosphorous was superior to the in-soil method on the uptake of total nitrogen in maize. The advantage of foliar phosphorus spraying over in-soil application is that because leaf tissue has the same morphological structure as root tissue (they both originate from the meristem tissue), plants can rapidly absorb dissolved minerals **(Martinka *et al.*, 2014)**. Foliar fertilizing can thus successfully manage soil deficiency in micro-elements **(Barbosa *et al.*, 2013 and Tejada *et al.*, 2018)**. Also, the superiority of the higher nitrogen rate over the total nitrogen uptake is due to the direct effect of increasing the concentration of nitrogen in living tissues, as well as the indirect effect on raising the yield of maize grain and stover **(Shrestha *et al.*, 2018)**. **Hammad *et al.*,(2017)**, showed that nitrogen concentrations in the stem and grain of maize increased linearly as N fertilizer rates were increased with irrigation water.

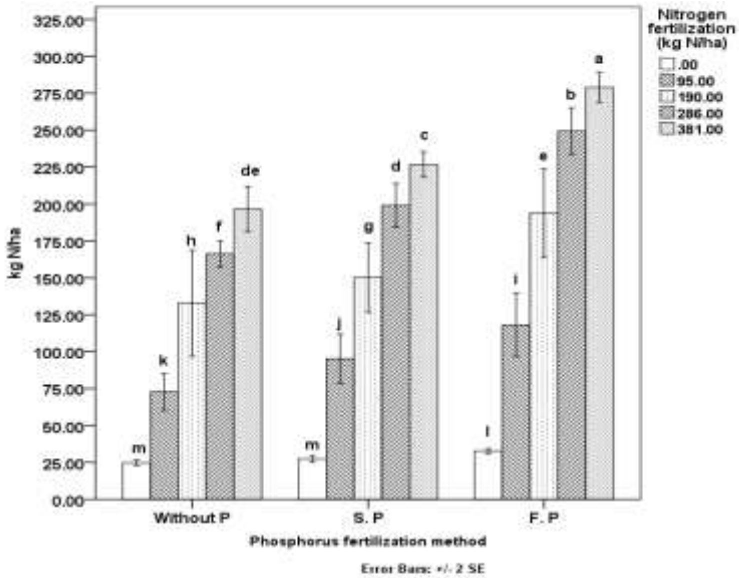

Fig. 10. Pooled analysis of total nitrogen uptake in maize (kg N ha^{-1}) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

Nitrogen use efficiencies

Data in Table 6 showed the effect of phosphorus fertilization method & nitrogen fertilization rates and their interaction were significantly (P<0.01) on agronomic efficiency ($kg_{grain}/kg_{N\ applied}$), physiological efficiency ($kg_{grain}/kg_{N\ uptake}$) & apparent recovery efficiency (%) of maize nitrogen in both seasons and pooled analysis. As for the factor of phosphorous fertilization methods, the highest results of nitrogen use efficiencies of maize (AE, PE and RE%) were obtained with the application of phosphorus fertilization by foliar, followed by soil phosphorous fertilization. On the other hand, the highest values of AE, PE and RE% obtained with 95 kg ha^{-1} followed by 190, 286 and 381 kg N ha^{-1}, respectively.

The interaction effect on agronomic nitrogen efficiency of maize (Fig 11) showed that the highest values obtained with (95 kg N ha^{-1} + foliar phosphorus) followed by (190 kg N ha^{-1} + foliar phosphorus), (95 kg N ha^{-1} + soil phosphorus) and (190 kg N ha^{-1} + soil phosphorus), respectively with a significant difference.

While the interaction effect on physiological nitrogen efficiency of maize (Fig 12) showed that the highest values obtained with (95 kg N ha^{-1} + soil phosphorus) followed by (95 kg N ha^{-1} + foliar phosphorus) with no significant difference. Also, in Figure 12, it is noticed that there were no significant differences between the effect of (95 kg N ha^{-1} + foliar phosphorus) and (190 kg N ha^{-1} + soil phosphorus), as well as between (190 kg N ha^{-1} + foliar phosphorus) and (95 kg N ha^{-1} + without phosphorus), also, between (190 kg N ha^{-1} + without phosphorus) and (286 kg N ha^{-1} + without phosphorus), as well, between (286 kg N ha^{-1} + without phosphorus) and (286 kg N ha^{-1} + soil phosphorus), also, between (286 kg N ha^{-1} + soil phosphorus) and (381 kg N ha^{-1} + without phosphorus), between (381 kg N ha^{-1} + without phosphorus) and (381 kg N ha^{-1} + soil phosphorus) and also, between (381 kg N ha^{-1} + soil phosphorus) and (286 kg N ha^{-1} + foliar phosphorus) on physiological nitrogen efficiency of maize.

Apparent recovery efficiency (%) of maize nitrogen as affected by the interaction between phosphorus fertilization methods and nitrogen fertilization rates is shown in Fig 13. It showed that the highest values obtained with (95 kg N ha^{-1} + foliar phosphorus) followed by (190 kg N ha^{-1} + foliar phosphorus), (286 kg N ha^{-1} + foliar phosphorus) and (381 kg N ha^{-1} + soil phosphorus), respectively with a significant difference. Also, it is noticed in Figure 12 that there were no significant differences between the effect of (190 kg N ha^{-1} + soil phosphorus) and (381 kg N ha^{-1} + foliar phosphorus) and also, between (381 kg N ha^{-1} + soil phosphorus) and (95 kg N ha^{-1} + without phosphorus).

In terms of phosphorus fertilization methods, the highest nitrogen use efficiencies of maize (AE, PE, and RE %) were obtained with foliar phosphorus fertilization, followed by soil phosphorous fertilization. However, when it comes to nitrogen fertilization, the highest values of AE, PE, and RE % were obtained with 95 kg ha-1, followed by 190, 286, and 381 kg N ha-1, respectively. In general, a high PE indicated a nitrogen deficiency, whereas a low one indicated poor internal conversion **(Dobermann, 2007)**. According to **Fageria *et al.*,2009**, applying fertilizer N in amounts greater than what is required to produce economic yields results in high N losses and low N use efficiencies **(Fageria *et al.*, 2008)**. Furthermore, the agronomic N use efficiency of maize decreased linearly as N levels increased, thus, the low N utilization efficiencies imply significant N losses or immobilization **(Lucas *et al.*, 2019)**. The top application of mineral N fertilizer most likely resulted in the majority of the mineral N fertilizer being found on or near the soil surface, with significant potential for N leaching and volatilization losses in this slightly alkaline soil **(Mosaad *et al.*, 2020)**. The results of the present study in this regard showed that the use of foliar fertilization with phosphorous with any level of nitrogen fertilization led to a higher use efficiency of nitrogen, and therefore it is recommended to use foliar fertilization with phosphorous so that there was no significant loss in mineral nitrogen fertilization by raising the efficiency of maize to use nitrogen.

Table 6: Means of maize Agronomic, Physiological and Apparent recovery efficiencies of nitrogen as affected by phosphorous addition methods and nitrogen fertilization rates in 2020 & 2021 summer seasons.

Treatment	Agronomic efficiency (AE) (kg $_{grain}$/kg $_{N\ applied}$)			Physiological efficiency (PE) (kg $_{grain}$/kg $_{N\ uptake}$)			Apparent recovery efficiency (RE) (%)		
	1st	2nd	Pooled analysis	1st	2nd	Pooled analysis	1st	2nd	Pooled analysis
Phosphorus fertilization Method									
Without P	**12.942**	**13.014**	**12.978**	**25.894**	**26.046**	**25.970**	**40.770**	**39.984**	**40.377**
S. P	**17.114**	**17.115**	**17.114**	**27.896**	**26.864**	**27.380**	**48.753**	**50.640**	**49.697**
F. P	**20.889**	**20.738**	**20.813**	**26.836**	**25.525**	**26.181**	**61.700**	**64.318**	**63.009**
Total	**16.982**	**16.956**	**16.969**	**26.875**	**26.145**	**26.510**	**50.408**	**51.647**	**51.028**
p value	**0.000**	**0.000**	**0.000**	**0.009**	**0.000**	**0.002**	**0.000**	**0.000**	**0.000**
Nitrogen fertilization rates (kg N ha^{-1})									
Without N	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
95.00	**26.197**	**25.614**	**25.906**	**37.714**	**35.673**	**36.693**	**69.549**	**71.706**	**70.627**
190.00	**23.633**	**24.210**	**23.921**	**34.485**	**35.681**	**35.083**	**69.194**	**68.314**	**68.754**
286.00	**19.089**	**19.024**	**19.057**	**31.798**	**30.274**	**31.036**	**60.337**	**63.147**	**61.742**
381.00	**15.990**	**15.930**	**15.960**	**30.379**	**29.099**	**29.739**	**52.959**	**55.071**	**54.015**
Total	**16.982**	**16.956**	**16.969**	**26.875**	**26.145**	**26.510**	**50.408**	**51.647**	**51.028**
p value	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
P.M. × N									
p value	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

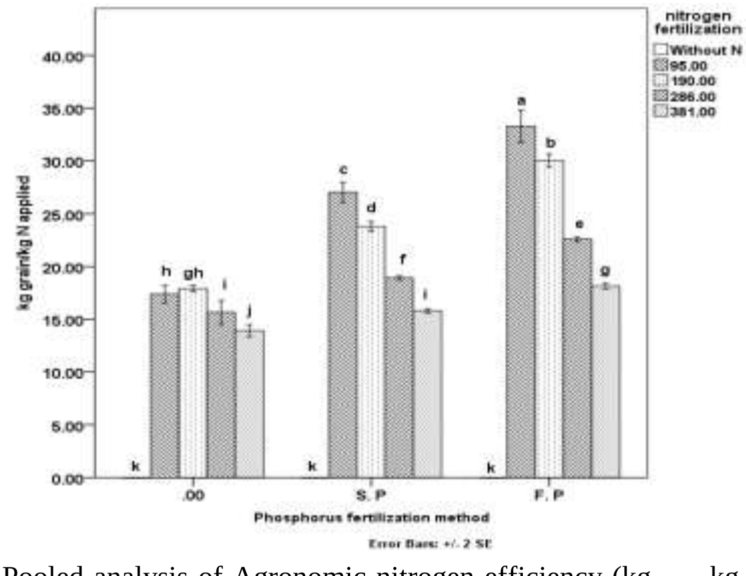

Fig. 11 Pooled analysis of Agronomic nitrogen efficiency (kg $_{grain}$ kg $_{N\ applied}^{-1}$) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

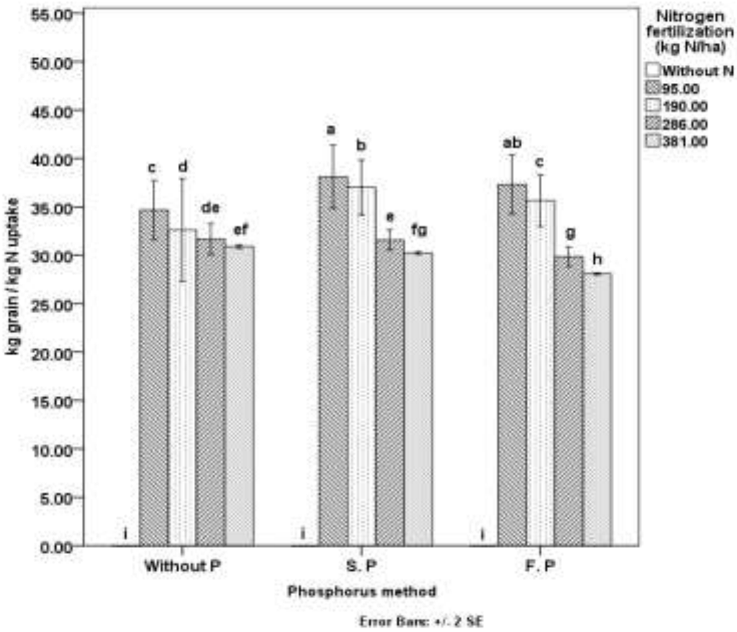

Fig. 12 Pooled analysis of Physiological nitrogen efficiency (kg $_{grain}$ kg $_{N\ uptake}{}^{-1}$) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

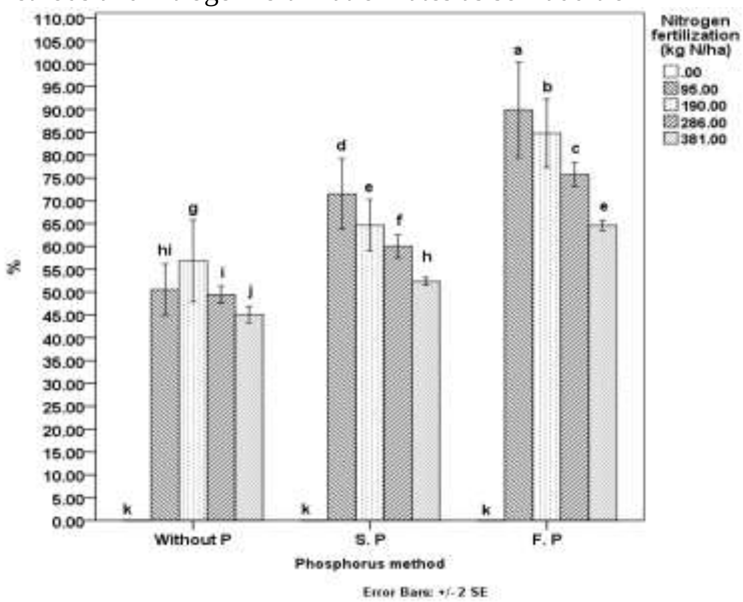

Fig. 13: Pooled analysis of Apparent nitrogen recovery (%) affected by the interaction effect between phosphorous addition methods and nitrogen fertilization rates as soil-addition

CONCLUSIONS

The results of the current study showed that the foliar spraying of phosphorous led to an increase in the amount of nitrogen uptake in maize grains & stover, and outperformed the soil treatment of phosphorous, thus raising the efficiency of nitrogen fertilization for maize grown in saline soil. Therefore, it could be recommend the use of foliar fertilization with phosphorous to increase the yield of grain and stover by 41.2 and 38.07%, respectively, as well as raise the grain protein and oil yield by 54.89 and 80.6%, respectively. Also using of 381 kg N ha^{-1} to obtain a higher grain and stover yield by 251.28 and 197.34%, respectively, and a higher protein and oil yield by 621.15 and 322.07%, respectively, compared with the control treatments without phosphate and nitrogen fertilization. So, using 381 kg N ha^{-1} + foliar phosphorus at 144 mM KH_2PO_4 at a rate of 460 L ha^{-1} to obtain the economic yield of maize grain, stover, protein, and oil under salinity stress. Thus, taking advantage of the vast areas that suffer from high salinity of soil and irrigation water in the cultivation of an economical crop such as maize, to produce grains and oil, and make use of stover to make silage for animals feeding.

REFERENCES

AOAC, (2005). Association of Official Analytical Chemists. "Official Methods of Analysis", 18^{th} ed., AOAC International, Washington, DC.

Barbosa, R.H. ; L.A. Tabaldi ; F. R. Miyazaki ; M. Pilecco ; S.O. Kassab, and D. Bigaton (**2013**). Foliar copper uptake by maize plants: Effects on growth and yield. Ciência Rural, 43:1561–1568.

Blumenthal, J. M. ; D. D. Baltensperger ; K. G. Cassman ; S. C. Mason, and A. D. Pavlista (**2008**). Chapter 3 - Importance and Effect of Nitrogen on Crop Quality and Health. pp 51–70 *in* J. L. Hatfield and R. F. B. T.-N. in the E (Second E. Follett, editors. Academic Press, San Diego.

Buczko, U. and R.O. Kuchenbuch (**2007**). Phosphorus indices as risk-assessment tools in the USA and Europe-A review. J. Plant Nut. and Soil Sci., 170:445–460.

Cucci, G. ; G. Lacolla ; F. Boari ; M. A. Mastro and V. Cantore (**2019**). Effect of water salinity and irrigation regime on maize (*Zea mays* L.) cultivated on clay loam soil and irrigated by furrow in southern Italy. Agric. Water Manage., 222:118–124.

David, F. (2007). Salt Accumulation Processes. North Dakota state Univ., Fargo ND 58105.

Davies, B.; J.A. Coulter and P.H. Pagliari (**2020**). Timing and rate of nitrogen fertilization influence maize yield and nitrogen use efficiency. PLOS ONE 15:e0233674.

Dobermann, A. (2007). Nutrient use efficiency–measurement and management.

Fageria, N.K. ; V.C. Baligar and Y.C. Li (**2008**). The role of nutrient efficient plants in improving crop yields in the twenty first century. J. Plant Nutr., 31:1121–1157.

Fageria, N. K. ; M.P. B. Filho ; A. Moreira and C.M. Guimarães (**2009**). foliar fertilization of crop plants. J. Plant Nutr., 32:1044–1064.

Farooq, M. ; M. Hussain ; A. Wakeel and K.H.M. Siddique (**2015**). Salt stress in maize: Effects, resistance mechanisms, and management. A review. Agron. for Sustainable Develop., 35:461–481.

Feng, G. ; Z. Zhang ; C. Wan ; P. Lu and A. Bakour (**2017**). Effects of saline water irrigation on soil salinity and yield of summer maize (*Zea mays* L.) in subsurface drainage system. Agric. Water Manage., 193:205–213.

Hammad, H. M. ; W. Farhad ; F. Abbas ; S. Fahad ; S. Saeed ; W. Nasim and H.F. Bakhat (**2017**). Maize plant nitrogen uptake dynamics at limited irrigation water and nitrogen. Environ. Sci. and Pollution Res., 24:2549–2557.

Huang, M. ; Z. Zhang ; Z. Sheng ; C. Zhu ; Y. Zhai ; P. Lu and D. Brinkman (**2019**). Soil salinity and maize growth under cycle irrigation in coastal soils. Agron. J., 111:2276–2286.

Jackson, M.L. (2005). Soil Chemical Analysis: Advanced course. UW-Madison Libraries Parallel Press.

Katerji, N. ; J.W. Van Hoorn ; A. Hamdy ; F. Karam and M. Mastrorilli (**1994**). Effect of salinity on emergence and on water stress and early seedling growth of sunflower and maize. Agric. Water Manage., 26:81–91.

Lucas, F.T. ; B.M.M.N. Borges and E.L.M. Coutinho (**2019**). Nitrogen fertilizer management for maize production under tropical climate. Agron. J., 111:2031–2037.

Martinka, M. ; M. Vaculík and A. Lux (**2014**). Plant Cell Responses to Cadmium and Zinc. pp 209–246 Appl. Plant Cell Biol. Springer.

Messina, P. (2019). Koppen climate classification system. McGraw-Hill Education.

Mew, M. C. (2016). Phosphate rock costs, prices and resources interaction. Sci. of the Total Environ., 542:1008–1012.

Mosaad, I. S. M. ; A. H. I. Serag ; M. Moustafa-Farag and A.K. Seadh (**2020**). Effect of exogenous proline application on maize yield and the optimum rate of mineral nitrogen under salinity stress. J. Plant Nutr.,3:354–370.

Nelson, D. W. and L. E. Sommers (**1980**). Total nitrogen analysis of soil and plant tissues. J. AOAC., 63:770–778.

Olsen, S.R. ; C.V Cole ; F.S. Watanabe and L.A. Dean (**1954**). Estimation of Available Phosphorus in Soil by Extraction with Sodium Bicarbonate US Dept. Agric. Circ., 939.

Qayyum, A., H. M. Saeed, M. Hanif, E. Noor, W. Malik, S. Liaqat, K. Hanif, and N. Murtaza (**2016**). Exploitation of variability for salinity tolerance in maize hybrids (*Zea mays* L.) at early growth stage. Afr. J. Agric. Res., 11:4206–4213.

Raboy, V. (2013). The future of crop breeding for nutritional quality. SABRAO J.Breeding & Genetics 45.

Rafiullah, M. ; J. Khan and M. Dost (**2018**). Foliar application of phosphorus to enhance phosphorus utilization and crop growth: A hydroponic study. Sarhad J. Agric., 34.

Rafiullah, M. ; J. Khan ; D. Muhammad ; S. Fahad ; M. Adnan ; F. Wahid ; S. Alamri ; F. Khan ; K. M. Dawar ; I. Irshad ; S. Danish ; M. Arif, Amanullah ; S. Saud ; B. Khan ; I. A. Mian ; R. Datta ; T. Zarei ; A. A. Shah ; M. Ramzan ; M. Zafar-ul-Hye ; M. Mussarat and M. H. Siddiqui (**2020**). Phosphorus nutrient management through synchronization of application methods and rates in wheat and maize crops. Plants, 9.

Ray, K. ; H. Banerjee ; S. Dutta ; A. K. Hazra and K. Majumdar (**2019**). Macronutrients influence yield and oil quality of hybrid maize (*Zea mays* L.). PloS one 14:e0216939.

Rengel, Z. (2015). Availability of Mn, Zn and Fe in the rhizosphere. J. Soil Sci. and Plant Nutr., 15:397–409.

Richards, L. A. (1954). Diagnosis and improvement of saline and alkali soils. Soil Sci., 78.

Schoumans, O. F. ; F. Bouraoui ; C. Kabbe ; O. Oenema and K.C. van Dijk (**2015**). Phosphorus management in Europe in a changing world. Ambio., 44:180–192.

Shrestha, J. ; A. Chaudhary and D. Pokhrel (**2018**). Application of nitrogen fertilizer in maize in Southern Asia: A review. Peruvian J. Agron., 2:22–26.

Singh, S. ; N. Ghoshal and K. P. Singh (**2007**). Synchronizing nitrogen availability through application of organic inputs of varying resource quality in a tropical dryland agroecosystem. Appl. Soil Ecol., 36:164–175.

Snedecor, G. W. and W. G. Cochran (**1989**). Statistical Methods. Eighth edi. Iowa State University Press, Ames.

Stewart, W.M. ; D.W. Dibb ; A.E. Johnston and T.J. Smyth (**2005**). The contribution of commercial fertilizer nutrients to food production. Agron. J., 97:1–6.

Tagour, R.M.H. and I.S.M. Mosaad (**2017**). Effect of the foliar enrichment and herbicides on maize and associated weeds irrigated with drainage water. Annals of Agric. Sci., 62:183–192.

Tejada, M. ; B. Rodríguez-Morgado ; P. Paneque and J. Parrado (**2018**). Effects of foliar fertilization of a biostimulant obtained from chicken feathers on maize yield. Eur. J. Agron., 96:54–59.

Wahid, F. ; M. Sharif ; S. Fahad ; M. Adnan ; I. A. Khan ; E. Aksoy ; A. Ali ; T. Sultan ; M. Alam ; M. Saeed ; H. Ullah ; A. Basir ; M. Noor and N. A. Khan (**2019**). Arbuscular mycorrhizal fungi improve the growth and phosphorus uptake of mung bean plants fertilized with composted rock phosphate fed dung in alkaline soil environment. J. Plant Nutr., 42:1760–1769.

Wei-Dong, K. ; Z.H.U. Yong-Guan ; F.U. Bo-Jie ; H.A.N. Xiao-Zeng ; L. Zhang and H.E. Ji-Zheng (**2008**). Effect of long-term application of chemical fertilizers on microbial biomass and functional diversity of a black soil. Pedosphere, 18:801–808.

Westerman, R. L. (1991). Soil Testing and Plant Analysis, Third Edition. Page Soil Science. Third edition. WI: Soil Science Society of America., Madison.

Zeng, W.Z. ; T. Ma ; J.S. Huang and J.W. Wu (**2016**). Nitrogen transportation and transformation under different soil water and salinity conditions. Ecological Chem. and Engin., S 23:677–693.

Zhang, W. ; X.X. Chen ; Y.M. Liu ; D.Y. Liu ; Y.F. Du ; X.P. Chen and C.Q. Zou (**2018**). The role of phosphorus supply in maximizing the leaf area, photosynthetic rate, coordinated to grain yield of summer maize. Field Crops Res., 219:113–119.

محاولة زيادة كمية الزيت في الذره المنزرع في اراضي متأثره بالملوحة بواسطة معاملات التسميد المختلفة

أحمد السيد مصطفى اللبان [1]، شريف عبد الغنى أبو الجود [2] وإبراهيم سعيد محمد مسعد [3]

[1] قسم بحوث الزيوت و الدهون – معهد بحوث تكنولوجيا الاغذية – مركز البحوث الزراعية – الجيزة – مصر.

[2] قسم بحوث محاصيل العلف – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة – مصر.

[3] قسم بحوث الأراضى وتغذية النبات – معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – مصر.

كان الهدف الاساسى من هذه الدراسه هو استخدام طرق ومعدلات تسميد مختلفه لزياده كميه الزيت فى الذره من وحده المساحه للمساهمه فى سد جزء من الفجوه فى زيوت الطعام. لذلك تم إجراء تجربتين حقليتين بمحطة بحوث السرو الزراعية ، مركز البحوث الزراعية ، محافظة دمياط لبيان تأثير طريقتين للتسميد الفوسفاتي (رش على الأوراق واضافة أرضية) وخمسة معدلات تسميد بالنيتروجين (0 ، 95 ، 190 ، 286 ، 381 كجم نتروجين/هكتار) وتفاعلها على محصول الحبوب والحطب وبعض التركيب الكيميائي للذرة في موسمي 2020 و 2021. أشارت النتائج المتحصل عليها إلى أن استخدام التسميد الورقي الفوسفاتى أدى إلى زيادة إنتاجية الحبوب والحطب بنسبة 41.2 و 38.07٪ على التوالي ، وكذلك زيادة إنتاجية بروتين الحبوب والزيوت بنسبة 54.89 و 80.6٪. كما بينت أن إضافة 381 كجم نتروجين/هكتار أدى إلى زيادة إنتاجية الحبوب والحطب بنسبة 251.28 و 197.34٪ على التوالي ، وكذلك زيادة إنتاجية البروتين والزيت بنسبة 621.15 و 322.07٪ على التوالي ، مقارنة بمعاملات المقارنة التي لم تستخدم فيها الفوسفات أو سماد نيتروجين. وقداعطت هذه المعاملات نتائج جيده فى زياده كميه الزيت لوحده المساحه مع تعظيم الاستفاده من الاراضى المتاثره بالاملاح لهذا الغرض. كما أدت المعالجة الورقية بالفوسفور إلى زيادة كفاءة الاستفادة من النيتروجين بكافة معدلات التسميد بالنيتروجين. وبالتالي ، الاستفادة من المناطق الشاسعة ذات الملوحة العالية للتربة ومياه الري في زراعة محصول اقتصادي مثل الذرة لإنتاج الحبوب والزيوت للمساهمه فى سد جزء من الفجوه فى زيوت الطعام ، وكذلك الحطب لتصنيع السيلاج لتغذية الحيوانات.