INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

IJPAES

Volume-4, Issue-4, Oct-Dec-2014

ISSN 2231-4490
Copyrights@2014
Coden : IJPAES www.ijpaes.com

Received: 4th Aug-2014 *Revised: 20th Aug-2014* *Accepted: 21st Aug-2014*

Research article

EFFECT OF PHOSPHATE BIOFERTILIZE AND DIFFERENT LEVELS OF CHEMICAL PHOSPHORUS FERTILIZER APPLICATION ON GROWTH AND YIELD OF MAIZE (Zea mays L.)

Shno Othman Sofy [*] and Ahmad Hama Ameen Hama Rashid[**]

[*,**]Dep. of Field Crops, Faculty of Agric. Sciences / University of Sulaimani/Iraqi Kurdistan Region Iraq. Corresponding author, e-mail: drahmad1955@gmail.com

ABSTRACT. The present study was conducted to study the effect of biofertilizer and different levels of chemical phosphorus fertilizer on yield of corn plant (*Zea mays* L. var. Single Cross 704). This present investigation was conducted at two different locations in Sulaimani Governorate. The first location was Kanypanka and the second location was Qlyasan Research Stations about 35 km faraway from each other during the spring season of 2012. Both field experiments were laid out using factorial Complete Randomized Block Design (CRBD) with three replications for both locations. The first factor involved of two levels of phosphate biofertilizer (B_0 =non-inoculated treatment and B_1= inoculated treatment - PBf) and the second factor was phosphorus fertilizers in a form of triple super phosphate (TSP - P_2O_5 48%) and has been applied at four levels (0, 40, 80 and 120) kg P ha^{-1}. Generally, the results indicated that the PBf treatment (B_1) had significant effects on all reproductive characters with exception of biological yield at both locations and their average and No. of rows ear^{-1} at Qlyasan location. The highest kernel yield values (11252.78, 10943.05 and 11097.91) kg ha^{-1} and HI values (0.43, 0.46 and 0.44) were recorded in B_1 at both locations and their average, respectively. Other reproductive characters including weight of 500 kernel (g) (142.15, 116.00 and 129.28) g and No. of kernels ear^{-1} (400.29, 487.17 and 443.73) were also significantly affected by B_1 treatment at both locations and their average. The results also showed that all reproductive characters were significantly affected by TSP with the exception of biological yield (kg ha^{-1}) at both locations and their average, weight of 500 kernels (g) at both locations and the characters, No. of rows ear^{-1}, No. of ear $plant^{-1}$ and harvest index at Qlyasan location. The treatment P_3 produced the highest kernel yield values (10893.28 and 10314.29) kg ha^{-1} at Kanypanka location and the average of both locations and the treatment P_2 gave a value of (10708.57 kg ha^{-1}) at Qlyasan location, while the minimum values for almost all characters were recorded by P_0 at both locations and their average. The results, indicated also that the interaction between PBf and TSP levels had significant effect only on No. of kernels row^{-1} (31.83 for B_1P_3) at Kanypanka location, and on No. of kernels row^{-1} (37.41 and 32.75 for B_1P_1 and B_1P_3), on No. of kernels ear^{-1} (527.77 and 499.34 for B_0P_1 and B_1P_3) and on weight of 500 kernels (g) (121.75 and 131.74) g for B_1P_0, at Qlyasan location and the average of both locations, respectively. The maximum values of protein (13.17, 11.26 and 12.21%) and phosphorus (P) content (1.261, 0.87 and 1.06) mg kg^{-1} in maize kernel were obtained by PBf treatment at both locations and their average, respectively. There were also significant effects of TSP (P_3) level on protein and (P) content in maize kernel, at Kanypanka location and the average of both locations, but at Qlyasan (P_2) level has significantly exceeded the other P levels in (P) content. Finally, the significant effect of interaction between PBf and TSP levels on protein in maize kernels values (13.62 and12.47)% were recorded by B_1P_3, but Phosphorus content did not reach the significant difference at Kanypanka and the average of both locations, , while the protein and phosphorus content did not reach the significant level at Qlyasan location.

Key words: *Zea mays L*; Phosphate biofertilizer; Chemical phosphorus fertilizer; Protein content; Phosphorus content.

INTRODUCTION

Corn (*Zea mays* L.) is a member of the grass family (Gramineae); it has now risen to a commercial crop on which many agro-based industries depend for raw materials (Iken and Amusa, 2004). Worldwide production was 817 million tons in 2009, more than rice (678 million tons) or wheat (682 million tons) [1].

The most important constraint limiting for maize crop yield in developing nations worldwide, and especially among resource-poor farmers, is soil infertility. Therefore, maintaining soil quality can reduce the problems of land degradation, decreasing soil fertility and rapidly declining production levels that occur in large parts of the world which needing the basic principles of good farming practice [2]. For optimum plant growth, nutrients must be available in sufficient and balanced quantities [3]. After nitrogen (N), phosphorus (P) is the most limiting nutrient for crop yields, and is essential for maize growth and development [4]. Large quantities of chemical fertilizers are used to replenish soil N and P, resulting in high costs and severe environmental contamination [5]. Maize quantity and quality were increased by utilization of fertilizers (biofertilizer especially), which has become the most important objective of these products worldwide [6 and 7]. Phosphorus, is the second most important macro-nutrient required by the plants, next to nitrogen, is reported to be a critical factor of many crop production systems, due to the fact that the limited availability in soluble forms in the soils [8]. The low availability of P to plants is because the vast majority of soil P is found in insoluble forms, and plants can only absorb P in two soluble forms, the monobasic ($H_2PO_4^-$) and the dibasic (HPO_4^{2-}) ions [9]. Crop plants can therefore utilize only a fraction of applied phosphorus, which ultimately results in poor crop performance. To rectify this and to maintain soil fertility status, frequent application of chemical fertilizers is needed, though it is found to be a costly affair and also environmentally undesirable [10]. Biological phosphate fertilizers containing beneficial bacteria and fungi increased soluble phosphate by increasing soil acidity or alkaline phosphates enzyme, which can be absorbed by plants easily. Soil chemical and biological characteristics improved by biofertilizer; moreover due to the use of low doses of chemical fertilizers, hence agricultural production will be free from contaminants [11 and 12]. The organisms possessing phosphate solubilising ability called phosphate solubilising organisms (PSMs) [13], which are referred to a group of soil microorganisms that are a component of P cycle, capable of dissolving insoluble forms of phosphates into plant available forms. Several groups of microorganisms including fungi, bacteria and actinomycetes are known as efficient fixed P solubilizers [14]. One of the major problems in Iraqi soils including soils of Kurdistan region is that most of these soils contain high amount of calcium carbonate ($CaCO_3$), and cause a chemical and physical fixation of (70-90%) of the added phosphorus, due to high $CaCO_3$ content of the soils [15] and resulting in the decrease of available phosphorus for plants. However, utilization of phosphate solubilising microorganisms is found to be limited, lack of knowledge among practitioners being the key reason [16].
Therefore, the present study was conducted to evaluate the effect of phosphate biofertilizer and phosphorus chemical fertilizer (T.S.P 48% P_2O_5) and their interaction on growth**,** qualitative and quantitative characteristics of maize (SC 704).

MATERIALS AND METHODS

The field experiments were carried out at two different locations in Sulaimani region. The first location was Kanypanka Agricultural Research Centre of Sulaimani in Sharazur plain zone, 35 km east of Sulaimani city) and the second location was Qlyasan - The Research Station of Faculty of Agricultural Sciences - University of Sulaimani during the spring season of 2012.

Both field experiments were laid out according to factorial based Complete Randomized Block Design (CRBD) with three replications for both location. The first factor was consisted of two levels of phosphate biofertilizer (B_0 =non-inoculated treatment, B_1=inoculated treatment- PBf), the PBf was used as recommended by the producer (The pre sown seeds were inoculated with 100 g biofertilizer hectar^{-1}). The second factor was a chemical phosphorus fertilizer, Triple Super Phosphate (TSP - P_2O_5 48%) source, applied at four levels (0, 40, 80 and 120 kg P ha^{-1}), corresponding to half amount of phosphorus fertilizer recommended for calcareous soil. Thus the total Number of experimental units was (2×4×3=24) units of 9.10 m^2 (3.25m×2.80m) randomly distributed in each block. Each unit contained four rows.

The following outline shows the treatments used in this study and their symbols.

B_0P_0	Non-inoculated - PBf + 0 kg P ha^{-1}
B_0P_1	Non-inoculated - PBf + 40 kg P ha^{-1}
B_0P_2	Non-inoculated - PBf + 80 kg P ha^{-1}
B_0P_3	Non-inoculated - PBf + 120 kg P ha^{-1}
B_1P_0	Inoculated - PBf + 0 kg P ha^{-1}
B_1P_1	Inoculated - PBf + 40 kg P ha^{-1}
B_1P_2	Inoculated - PBf + 80 kg P ha^{-1}
B_1P_3	Inoculated - PBf + 120 kg P ha^{-1}

B_0= Non-inoculated –PBf; B_1= Inoculated –

Then the seeds were sown in rows with (75cm) between each two rows and (25cm) between plants, corn grains (*Zea mays*. SC 704 hybrid) were obtained from Agricultural Research Center of Sulaimani, the plant density mached (50000 plant ha^{-1}). The planting dates were (April 3 and 4, 2012) for both locations, Kanypanka and Qlyasan, location respectively. Nitrogen fertilizer was applied in form of (Urea 46% N) as recommended dose (200 kg ha^{-1}) [17]. The available P in the soil was determined after the harvest stage according to (18), as shown in (Table 1).

Table 1. Available P (mg P kg^{-1} Soil) in the soil of both locations after harvesting.

Phosphate biofertilizer	Phosphorus fertilizer	Kanypanka	Qlyasan
		mg P kg soil	
B_0	P_0	24.09	25.50
	P_1	19.47	29.90
	P_2	20.48	27.91
	P_3	37.55	30.12
B_1	P_0	21.48	21.48
	P_1	31.72	41.36
	P_2	32.12	41.76
	P_3	47.99	38.35

The studied characters

Chlorophyll content (mg g^{-1})

Was estimated at the time period specified (after flowering) by spectrophotometer according to the following equation (19).

µg chlo.a/ml solution = (13.7) (A665nm) – (5.76) (A649nm).

µg chlo.b/ml solution = (25.8) (A649nm) – (7.6) (A665nm).

A=absorbance

Total chlorophyll = **chl. a** + **chl. b**

Biological yield (kg ha^{-1}); Kernel yield (kg ha^{-1}); No. of rows ear $^{-1}$; No. of kernel row^{-1}; No. of kernel ear^{-1}; No. of ears $plant^{-1}$.

Weight of 500 kernels (g): Measured at post harvesting.

Harvest Index (HI: Was calculated by the following equation, and according to (20):

Harvest index (%) = (Economic yield /Biological yield) × 100

Protein percent (%): Protein content in the seeds was determined by using Kjeldahl method as recommended by (21).

Protein% in seeds= total nitrogen% in seed x 6.25

Phosphorus (P) content in the kernels (mg Kg^{-1}): Phosphorus was determined according to the colorimetric method as described by (22).

Statistical analysis

The experimental data for both locations were statistically analyzed according to the XLSTAT of variance as a general test and (JMP. Version 8) analysis was used to combine two locations; all possible comparisons among the means were calculated following L.S.D test (Least Significant Different) at significant level of (0.05).

RESULTS AND DISCUSSION

Reproductive growth characters

Effect of phosphorus biofertilizer (PBf) on reproductive growth characters:

Table (2) revealed that the maximum Kernel yield values were (11252.78, 10943.05 and11097.91) kg ha^{-1} recorded by (B_1), while minimum value for the same character was (7179.64, 10675.48 and 8927.56) kg ha^{-1} was recorded by B_0 at Kanypanka and Qlyasan locations and their average, respectively. Increase of grain yield can be attributed to the ability of phosphate solubilizing bacteria in Phosphate biofertilizer in increasing available phosphorus of insoluble phosphorus sources.

These results were in agreement with [23] they reported that with increasing phosphobacterin compounds, corn yield was increased. Maximum No. of rows ear $^{-1}$, No. of Kernel row $^{-1}$ and No. of Kernel ear^{-1}, recorded by B_1 treatments were (15.02, 26.54 and 400. 29) at Kanypanka location, (14.32, 33.96, and 487.17) at Qlyasan location and (14.673, 30.25, 443.73) at the average of both locations respectively compared to $B_0$where produced the minimum values for all mentioned characters. Results in (Table 2) also followed similar trend as previous reproductive characters where the No. of ear plant $^{-1}$, weight of 500 Kernels (g) and Harvest Index (HI) were significantly increased by B_1 treatment, producing the highest values (1.93, 142.15 and 0.43) at Kanypanka location, (1.93, 116.00 and 0.46) at Qlyasan location and (1.93, 129.28 and 0.44) compared to the lowest values recorded by all B_0 treatment. The researchers (24) reported that P is the important nutrient for plant growth, absorbed mainly during the vegetative growth; therefore most of its absorbed form is re-translocated to the fruits and seeds during the reproductive stages.

Table 2. Effect of PBf on the reproductive growth characters at Kanypanka and Qlyasan Locations and their average.

PBf	No. of rows ear $^{-1}$	No. of Kernel row^{-1}	No. of Kernel ear $^{-1}$	No. of ear plant $^{-1}$	Weight of 500 Kernels(g)	Kernel yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (HI)
Kanypanka								
B_0	13.20	19.97	266.03	1.58	118.71	5128.31	25798.8	0.19
B_1	15.02	26.54	400.29	1.93	142.15	11252.78	26074.72	0.43
$LSD_{0.05}$	0.49	0.66	16.11	0.16	7.00	1689.67	N.S.	0.03
Qlyasan								
PBf	No. of rows ear $^{-1}$	No. of Kernel row^{-1}	No. of Kernel ear $^{-1}$	No. of ear plant $^{-1}$	Weight of 500 Kernels(g)	Kernel yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (HI)
B_0	13.77	31.12	432.61	1.62	106.54	7625.34	22156.62	0.34
B_1	14.32	33.96	487.17	1.93	116.00	10943.05	23525.6	0.46
$LSD_{0.05}$	N.S.	1.08	33.93	0.15	2.62	1713.57	N.S.	0.08
Average of locations								
PBf	No. of rows ear $^{-1}$	No. of Kernel row^{-1}	No. of Kernel ear $^{-1}$	No. of ear plant $^{-1}$	Weight of 500 Kernels(g)	Kernel yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (HI)
B_0	13.48	25.55	349.32	1.60	112.54	6376.82	23977.71	0.26
B_1	14.67	30.25	443.73	1.93	129.28	11097.91	24800.15	0.44
$LSD_{0.05}$	0.44	0.61	17.91	0.10	1.79	1167.57	N.S.	0.04

Effect of (TSP) levels on reproductive growth characters

Table (3) showed that all characters were significantly affected by (TSP) levels with the exception of biological yield (kg ha^{-1}) at both locations and their average, weight of 500 Kernels (g) at locations and characters, No. of ear plant^{-1} and harvest index% in Qlyasan location. Although the results were not significant but the maximum biological yield values (26941.55 kg ha^{-1}) was recorded by (P_3) level at Kanypanka location and (24426.08 and24960.86) kg ha^{-1} were recorded by (P_1 and P_2) level at Qlyasan location and the average of both location respectively, compared to the minimum values (25425.67 kg ha^{-1}) recorded by (P_1) at Kanypanka location and (2140.95 and 23438.4 kg ha^{-1}) recorded by (P_0) at Qlyasan location and the average respectively.

Regarding the effect of (TSP) levels on the characters of yield and yield components of maize, a significant differences were found among them as an example, at Kanypanka location, the maximum values were recorded by P_3 levels for Kernel yield with (10893.28 kg ha^{-1}), No. of rows ear $^{-1}$ with (14.62), No. of Kernel row^{-1} with (28.25), No. of Kernel ear $^{-1}$ with (416.02) and HI% with(0.40), while P_2 level gave maximum values in No. of ear plant $^{-1}$with (1.91). However at Qlyasan location, most of the studied characters were generally increased with increasing levels of phosphorus fertilizer, while the minimum values for almost all characters were recorded by P_0 at both locations and their average.

Moreover at Qlyasan location it was appeared clearly that P_2 gave the highest values significantly in Kernel yield with (1200 kg ha^{-1})and non-significantly in weight of 500 Kernels (113.20 g),while P_1 level gave values significantly higher than other levels in No. of Kernel row^{-1} (37.00), No. of Kernel ear^{-1} with(521.43), and P_3 exceeded other treatments but non-significantly in No. of rows ear $^{-1}$ with (14.54) No. of ear plant $^{-1}$ (1.91), and HI% with (0.45). For the average of both locations increasing phosphorus levels caused increases in most studied characters, for example P_3 level gave maximum Kernel yield, No. of rows ear^{-1}, No. of ear $plant^{-1}$ and HI with values (10314.29 kg ha^{-1}, 14.58, 1.89 and 0.42) respectively .While P_2 gave the highest values in No. of Kernel row^{-1} with (30.29), No. of Kernel ear $^{-1}$ with (441.38) and weight of 500 Kernels with (124.00g). The data in the same table also revealed the minimum values for all studied characters, recorded by (P_0) at both locations and their average. These results were in agreements with those by 25].

Table 3. Effect of TSP on the reproductive growth characters of maize at Kanypanka and Qlyasan locations and their average.

TSP	No. of rows ear $^{-1}$	No. of Kernel row^{-1}	No. of Kernel ear $^{-1}$	No. of ear plant $^{-1}$	Weight of 500 Kernels(g)	Kernel yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (HI)
Kanypanka								
P_0	13.250	19.458	262.45	1.500	128.50	5388.11	25475.91	0.21
P_1	14.042	20.167	285.06	1.750	127.43	657.65	25425.67	0.25
P_2	14.542	25.167	369.11	1.917	134.62	9909.15	25903.90	0.38
P_3	14.625	28.250	416.02	1.875	131.17	10893.28	26941.55	0.40
$LSD_{0.05}$	0.696	0.938	22.78	0.238	N.S	2389.56	N.S	0.05
Qlyasan								
TSP	No. of rows ear $^{-1}$	No. of Kernel row^{-1}	No. of Kernel ear $^{-1}$	No. of ear plant $^{-1}$	Weight of 500 Kernels (g)	Kernel yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (HI)
P_0	13.06	25.97	340.83	1.62	111.27	6492.51	21400.95	0.30
P_1	14.08	37.00	521.43	1.75	111.90	10200.39	24426.08	0.41
P_2	14.50	35.41	513.65	1.83	113.20	10708.57	24017.82	0.44
P_3	14.54	31.79	463.65	1.91	108.71	9735.3	21519.6	0.45
$LSD_{0.05}$	N.S	1.089	47.98	N.S	N.S	2423.35	N.S	N.S
Average of locations								
TSP	No. of rows ear $^{-1}$	No. of Kernel row^{-1}	No. of Kernel ear $^{-1}$	No. of ear plant $^{-1}$	Weight of 500 Kernels (g)	Kernel yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (HI)
P_0	13.159	22.715	301.647	1.562	119.88	5940.31	23438.42	0.25
P_1	14.062	28.583	403.250	1.750	119.66	8386.02	24925.87	0.33
P_2	14.520	30.291	441.385	1.875	124.00	1308.86	24960.86	0.41
P_3	14.583	30.020	439.839	1.895	120.77	10314.29	24230.57	0.42
$LSD_{0.05}$	0.6340	0.872	25.328	0.151	2.543	1651.19	N.S	0.061

Effect of the interaction between (PBf) and (TSP) levels on reproductive growth characters

Table (4) indicated that only the following characters, were significantly affected by the effect of interaction between (PBf) and (TSP) levels and the characters were; No. of Kernel row^{-1} (the highest was 31.83 for B_1P_3) at Kanypanka location, and No. of Kerne row^{-1} (the highest were 37.41 and 32.75 for B_1P_1 and B_1P_3), No. of Kernel ear^{-1} (527.77 and 499.34 for B_0P_1 and B_1P_3) and weight of 500 Kernels (g) (121.75 and 131.74 g for B_1P_0) at Qlyasan location and the average of both locations respectively.

Generally the latter treatments gave higher values than (B_0P_0-control) treatments with the lower values. The superiority effect of biofertilizer treatments in comparison with control treatment can be attributed to increase in faster and higher up take of some mineral nutrients specially phosphorus that become more available due to the effect of (PBf) and supplying plant with available phosphorus, consequently causing increases in yield and yield components (26 and 27).

Table 4. Effect of Interaction between PBf and TSP on the reproductive growth characters at Kanypanka and Qlyasan locations and their average

PBf	TSP	No. of rows ear $^{-1}$	No. of Kernel row $^{-1}$	No. of Kernel ear $^{-1}$	No. of ear plant $^{-1}$	Weight of 500 Kernels(g)	Kernel yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (HI)
Kanypanka									
B_0	P_0	12.25	15.08	184.85	1.333	116.93	278.37	25833.328	0.10
	P_1	13.33	17.33	230.87	1.583	119.48	4342.6	24913.68	0.17
	P_2	13.41	22.83	307.22	1.750	122.12	6576.15	27051.7	0.24
	P_3	13.83	24.66	341.16	1.667	116.31	6813.11	25396.5	0.26
B_1	P_0	14.25	23.83	340.06	1.667	140.07	7994.84	25118.5	0.31
	P_1	14.75	23.00	339.25	1.917	135.38	8800.70	25937.67	0.33
	P_2	15.66	27.50	431.00	2.083	147.12	13242.15	24756.11	0.53
	P_3	15.41	31.83	490.87	2.083	146.03	14242.15	28486.61	0.52
$LSD_{0.05}$		N.S.	1.32	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Qlyasan									
B_0	P_0	12.58	22.50	283.22	1.41	100.78	4049.90	21020.22	0.19
	P_1	14.41	36.58	527.77	1.58	109.01	9151.92	22034.81	0.41
	P_2	14.08	35.50	499.97	1.66	111.53	9288.40	23906.11	0.38
	P_3	14.00	29.91	419.50	1.83	104.84	8011.14	21781.66	0.37
B_1	P_0	13.55	29.44	398.44	1.83	121.75	8935.12	21781.66	0.41
	P_1	13.75	37.41	515.10	1.91	114.79	11248.85	26817.36	0.41
	P_2	14.91	35.33	527.33	2.00	114.88	12128.75	24129.52	0.50
	P_3	15.08	33.66	507.81	2.00	112.59	1149.46	21373.82	0.53
$LSD_{0.05}$		N.S.	2.16	67.86	N.S.	5.24	N.S.	N.S.	N.S.
Average of both locations									
B_0	P_0	12.41	18.79	234.04	1.37	106.69	3415.64	2346.77	0.14
	P_1	13.87	26.95	379.32	1.58	114.24	6747.26	23236.15	0.29
	P_2	13.75	29.16	403.60	1.70	116.99	7932.27	25478.90	0.31
	P_3	13.91	27.29	380.33	1.75	112.24	7412.12	23530.92	0.31
B_1	P_0	13.90	26.63	369.25	1.75	131.74	8464.98	23450.07	0.36
	P_1	14.25	30.20	427.17	1.91	125.08	10024.77	27806.08	0.36
	P_2	15.29	31.41	479.16	2.04	131.00	12685.45	24442.82	0.51
	P_3	15.25	32.75	499.34	2.04	129.31	13216.45	24930.22	0.53
$LSD_{0.05}$		N.S.	1.23	35.82	N.S.	3.59	N.S.	N.S.	N.S.

Chemical Analysis

Protein (%)

Table (5) showed that the maximum values of protein% (13.17, 11.26 and 12.21) % were recorded by (B1) treatment as compared to (B0) treatment which gave the minimum values (10.76, 10.51 and10.63) % at Kanypanka and Qlyasan locations and their average respectively. The reason for the superiority of (PBf) could be due to its promotion of free living nitrogen fixing bacteria and enhancing nitrogen fixation, and then supplying of different nutrients like nitrogen, phosphorous, sulphur, iron and copper (28 and 29).

Table 5. Effect of PBf on protein percent and phosphorus content characters in maize Kernel at Kanypanka and Qlyasan locations and their average.

Kanypanka		
PBf	Protein %	Phosphorus content mg kg^{-1}
B_0	10.76	0.80
B_1	13.17	1.26
LSD $_{0.05}$	0.50	0.21
Qlyasan		
PBf	Protein %	Phosphorus content mg kg^{-1}
B_0	10.51	0.53
B_1	11.26	0.87
LSD $_{0.05}$	0.58	0.11
Average of both locations		
PBf	Protein %	Phosphorus content mg kg^{-1}
B_0	10.63	0.66
B_1	12.21	1.06
LSD $_{0.05}$	0.47	0.11

Table 6. Effect of TSP on protein percent and phosphorus content characters in maize kernel at Kanypanka and Qlyasan locations and their average.

Kanypanka		
TSP	Protein %	Phosphorus content mg kg^{-1}
P_0	9.36	0.58
P_1	12.77	1.11
P_2	12.64	1.11
P_3	13.10	1.31
LSD $_{0.05}$	0.72	0.30
Qlyasan		
TSP	Protein %	Phosphorus content mg kg^{-1}
P_0	10.89	0.56
P_1	11.13	0.56
P_2	10.84	0.87
P_3	10.67	0.77
LSD $_{0.05}$	N.S	0.60
Average of both locations		
TSP	Protein %	Phosphorus content mg kg^{-1}
P_0	10.01	0.59
P_1	11.83	0.83
P_2	11.88	0.99
P_3	11.97	1.04
LSD $_{0.05}$	0.67	0.15

Table (6) highest values (13.10 and 11.97%) of protein% in seeds were given by P_3 levels, while the lowest values (9.36 and 10.01%) were recorded by P_0 at Kanypanka locations and their average, respectively. However at Qlyasan location P_1 level gave the highest value (11.13%), whereas the lowest value was recorded by P_3 level (10.67) but it did not reach the significant level.

Table (7) indicated that there were significant differences between treatments where at Kanypanka and the average of both locations. The maximum protein percent of (13.62 and12.47) % were recorded by B_1P_3 treatment respectively. Moreover, at Qlyasan location, although there were no significant differences among (PBf and TSP) treatments, but the results also showed that inoculated treatment without adding P level had superiority on non-inoculated treatments at all levels of phosphorus. The result was agreement with (30).

Phosphorus (P) content in maize Kernel (mg kg^{-1})

Table (5) showed that there were a significant differences between the effect of (PBf) treatments on the Phosphorus content in maize Kernel where B_1 exceeded B_0 treatments by (56.84, 62.68 and 59.34) % at Kanypanka and Qlyasan locations and their average respectively, similar results were reported by (31), they showed that inoculation of phosphate solubilizing *Pseudomonas* and *Bacillus* species significantly increased seed phosphorus % compared to control in wheat crop.

Table 7. Effect of interaction between PBf and TSP on protein percent and phosphorus content characters in maize kernel at Kanypanka and Qlyasan locations and their average.

Kanypanka			
PBf	**TSP**	**Protein %**	**Phosphorus content mg kg^{-1}**
B_0	P_0	6.01	0.36
	P_1	12.48	0.95
	P_2	11.98	0.84
	P_3	12.58	1.05
B_1	P_0	12.70	0.80
	P_1	11.06	1.27
	P_2	13.30	1.39
	P_3	13.62	1.56
LSD $_{0.05}$		1.01	N.S.
Qlyasan			
PBf	**TSP**	**Protein %**	**Phosphorus content mg kg^{-1}**
B_0	P_0	9.67	0.37
	P_1	11.03	0.50
	P_2	10.97	0.61
	P_3	10.37	0.64
B_1	P_0	11.67	0.82
	P_1	10.75	0.61
	P_2	11.29	1.13
	P_3	11.31	0.90
LSD $_{0.05}$		N.S.	N.S.
Average of both locations			
PBf	**TSP**	**Protein %**	**Phosphorus content mg kg^{-1}**
B_0	P_0	7.84	0.37
	P_1	11.75	0.73
	P_2	11.47	0.72
	P_3	11.47	0.84
B_1	P_0	12.19	0.81
	P_1	11.90	0.94
	P_2	12.29	1.26
	P_3	12.47	1.23
LSD $_{0.05}$		0.95	N.S.

Table (6) showed that increasing in Phosphorus content via increasing phosphorus level, the maximum values were recorded by P_3 level which was (1.311 and 1.044) mg kg^{-1} at Kanypanka and the average of both locations respectively, while at Qlyasan location P_2 level recorded the maximum value with 0.874 mg kg^{-1}. However there were no significant differences between the effects of P_2 and P_3 treatments, the minimum values were recorded by B_0 treatments. Table (7) showed that inoculated fertilized treatments gave values higher than non-inoculated fertilized treatments, but the differences did not reach the significant level. At Kanypanka location maximum value was obtained by inoculated treatment using P_3 level which increased by (49.14 %) compared to non-inoculated for the same level of phosphorus, while at Qlyasan and for the average of both locations, the inoculated treatment with P_2 level increased P content by (85.62 and 74.51) % compared to non-inoculated for the same level of phosphorus. These results were in agreement with those by (30).

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The percentage of Protein and the phosphorus content in maize grains were differed in quantitative composition due to the effect of PBf treatment at both locations and for their average.
2. The values were for P_3 level at Kanypanka location and the average of both locations, P_2 at Qlyasan location, B_1P_3 at Kanypanka location and the average for both locations, B_1P_0 for protein % and B_1P_2 for (P) content at Qlyasan location.

Recommendations

1. In order to improve the crop productivity, application of phosphate biofertilizer as an environment ecofriendly fertilizer for other strategic cereal crops such as wheat and rice is recommended.
2. Application of (80 and 120 kg P ha^{-1}) with phosphate biofertilizer, is recommended to increase crop yield.
3. Studying other types of biofertilizers alone or in combinations to determine the most effective type to be used by farmers in Kurdistan region.
4. Studying and isolation of some microbial strains for phosphate solubilizing in Kurdistan region soils are recommended.

REFERENCES

[1] Food and Agriculture Organization of the United Nations, Statistics Division (FAO). 2009. Maize, rice and wheat: area harvested, production quantity, yield.

[2] Mohammadi K and Sohrab Y. 2012. Bacterial biofertilizers for sustainable Crop production: a review, ARPN J. of Agric. and Bio. Sci. 7(5), 307-316

[3] Chen J H. 2006. The Combined use of Chemical and organic Fertilizers and/or biofertilizres for crop growth and soil fertility, Department of Soil and Environ. Sci., National Chung Hsing Univ.

[4] Wu S C, Cao Z.H., Li Z.G., Cheung K.C., and Wong M.H. 2005. Effects of biofertilizer containing N2-fixer, P and K solubilizers and AM fungi on maize growth: a greenhouse trial, Geoderma 125(1/2), 155-166

[5] Awodun, M A, Ojeniyi S O, Adeboye A. and Odedina S A. 2007. Effect of oil palm bunch refuse ash on soil and plant nutrient composition and yield of maize, American-Eurasian J.of Sustainable Agric. 1(1), 50-54.

[6] Al-Janabi A A S. 2006. Identification of Bacitracin produced by local isolate of Bacillus licheniformis, Afr. J. of Biotechno; 5 (18), 1600-1601.

[7] Hasaneen M N A, Younis M E, and Tourky S M N. 2009. Plant growth, metabolism and adaptation in relation to stress conditions XXIII. Salinity-biofertility interactive effects on growth, carbohydrates and photosynthetic efficiency of lactuca sativa, Plant Omics. 2(2), 60-69

[8] Xiao C Q, Chi R A,. Li X H, Xia M, and Xia Z W. 2011. Bio solubilization of rock phosphate by three stress-tolerant fungal strains, Chemical phosphorus fertilizer. Appl. Biochem.Biotech. 165, 719-727

[9] Glass A D M. 1989. Plant Nutrition: An Introduction to Current Concepts, Jones and Bartlett Publishers, Boston, MA, USA, 234.

[10] Reddy M S, Kumar S, and Babita K. 2002. Biosolubilization of poorly soluble rock phosphates by Aspergillus tubingensis. Bioresour. Technology. 84, 147-189.

[11] El-Habbasha S F, Hozayn M, and Khalafallah M A. 2007. Integration effect between phosphorus levels and biofertilizers on quality and quantity yield of faba bean *(vicia faba l.)* in newly cultivated sandy soils, Res. J. of Agric. and Biolo. Sci. 3(6), 966-971

[12] Salimpour S, Khavazi K, Nadian H, Besharati H, and Miransari M. 2010. Enhancing phosphorous availability to canola (*Brassica napus L*.) using P solubilizing and sulfur oxidizing bacteria, Australian J. of Crop Sci. 4(5), 330-33

[13] Pradhan N and Sukla L B. 2005. Solubilization of inorganic phosphate by fungi isolated from agriculture soil, Afr. J. Biotechnol. 5, 850-854

[14] Sundara B, Natarajan V, and Hari K. 2002. Influence of phosphorus solubilizing bacteria on the changes in soil available phosphorus and sugarcane yields, Field Crops Res. 77, 43-49

[15] Al-Sulivani S I A. 1993. Physico-chemical behavior of orthophosphate and pyrophosphate in some calcareous soils from northern of Iraq, PhD, thesis, Univ. of Baghdad, Agric. Department of Soil and Water.(In Arabic).

[16] Prasanna A, Deepa V, Balakrishna M P, Deecaraman M P, Sridhar R, and Dhandapani P. 2011. Insoluble phosphate solubilization by bacterial strains isolated from rice rhizosphere soils from Southern India, Int. J. Soil Sci. 6, 134-141

[17] Mahmood, S.M.A. 2012. Response of maize *(Zea mays L.)* genotypes to temperature and light intensity under greenhouse and field condition, M.Sc. thesis, College of Agric.Univ. Of Sulaimani.

[18] Olsen S R, Cole C V, Watanabe F S, and Dean L A. 1954. Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate, Circ. No.939, USDA. U. S. Government Printing Office, Washington, D. C.

[19] Kundson L, Tibbitts W, Gerald A, and Edwareds E. 1997. Measurement of ozone injury determination of concentration, Department of Horticulture, Uni. of Wisconsin, Plant Physio. 60, 606-608

[20] Chapman S R and Lark M.P.C. 1976. Plants and their environment. Crop production principles and practices, W.H. Freeman and Company. New York, 160.

[21] A.O.A.C. 1991. *Official Methods of analysis15th Edition*, Assoc. off. Ana. Chem, Arlington, VA.

[22] Schuffeelen A C A, and Van Schauwenburg J C H. 1961. Quick test for soil and plant analysis used by small laboratories. Neth. J. Agric., 9, 2-16.

[23] Singaram P and Kothandaraman G V. 1993. Effect of phosphorus sources on maize yield, Madras Agric. J. 80(7), 402-403

[24] Eftekhari G, Fallah A R, Akbari G A, Mohaddesi A, and Allahdadi I. 2010. Effect of phosphate solubilising bacteria and phosphate fertilizer on rice growth parameters, Iranian J. of Soil Res. (Soil and Water Sci.), 23 (2).

[25] Al-Rawi A A H, Saad T M, and Abdullah R H. 2001. Effect of phosphorus level and time of application on the growth and yield of corn *(Zea mays L.)*, IPA J. Agric. Research, 11,150-158.

[26] Khalilian E H. 2006. Effects of sulfur oxidizing bacteria (Thiobacillus), nitrogen fixation (azospirilium and Azotobacter) on corn yield and yield components, number SC704. Thesis, Department of Agrono.Islamic Azad Uni. of Tabriz.

[27] Ojaghlou F. 2007. Effect of inoculation with biofertilizers (Azotobacter and phosphate fertilizer) on growth, yield and yield components of safflower, Thesis of Agric. Faculty of Agric. Islamic Azad Uni. of Tabriz.

[28] McMillan M. 2007. Promoting growth with PGPR, Soil Food web Canada Ltd. Soil Bio. Laboratory and Learning Centre, 32-34

[29] Cakmakci R, Donmez F, Aydın A, and Sahin A. 2006. Growth promotion of plants by plant growth-promoting rhizobacteria under greenhouse and two different field soil conditions, Soil Biol. Biochem. 38, 1482–1487.

[30] Galavi M, Yosefi K, and Ramrodi M. 2011. Effect of Bio-phosphate and Chemical Phosphorus Fertilizer Accompanied with Foliar Application of Micronutrients on Yield, Quality and Phosphorus and Zinc Concentration of Maize, J. of Agric. Sci. 3 (4), 22-29

[31] Afzal A, Ashraf A, Asad A S, and Farooq M. 2005. Effect of phosphate solubilizing microorganisms on phosphorus uptake, yield and yield traits of wheat *(Triticum aestivum L.)* in rainfed area, Int. J. Agric. Biol**.** 7, 1560-8530.