EFFECT OF BLENDED TRIPLE SUPERPHOSPHATE WITH UREA ON N, P CONCENTRATIONS IN PLANT AND GROWTH OF BROAD BEAN IN A GYPSIFEROUS SOIL

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ABSTRACT

A field experiment was conducted on a gypsiferous sandy clay loam soil to examine the effects of blending Triple superphosphate (TSP) with urea on N, P concentrations in plant and growth parameters of broad bean. The experiment was a factorial randomized complete block design (RCBD) with three replicates. The first factor was type of application as briquettes which include T1 (one layer of TSP between two layers of urea) and T2 (one layer of urea between two layers of TSP), the second factor was application depth (5 and 10 cm D1 and D2), and the third factor was application rate (1.0, 1.25, and 1.50 as much as N and P fertilizer recommended for broad bean, R1, R2 and R3). Broad bean was planted and the following growth parameters were taken: plant height, no. of leaves, plant dry weight, chlorophyll content, leaf area, N and P concentration in plant. Results showed that the following treatments: T1 of blending (briquette no. 1), D1 and R2 were significantly superior over other treatments in all growth parameters and N, P concentration in plant. The triple interaction treatment T1D1R2 was significantly superior over other treatments with values reached 60.99 cm, 442.7 leave plant^{-1}, 20.32 cm^{2}, 63.87 Spad, 5.59 g plant^{-1}, 5.55 %, and 0.27 %, respectively for plant height, no. of leaves plant^{-1}, leaf area, chlorophyll content, plant dry matter, N and P conc. in plant.

Keywords: TSP, urea, fertilizer blending, gypsiferous soils.

تأثير خليط السوبرفوسفات الثلاثي مع اليوريا في تراكيز النايتروجين والفسفور في النبات ونمو الباقلاء في تربة جبسية

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المستخلص

أجريت تجربة حقلية في تربة مزيجة طينية رملية جبسية لتحديد تأثيرات خلط السوبرفوسفات الثلاثي (TSP) مع اليوريا في تراكيز النايتروجين (N) والفسفور (P) في النبات ومعايير نمو الباقلاء. التجربة كانت عاملية بتصميم العشوائية الكاملة (RCBD) بثلاث مكررات. كان العامل الأول هو نوع الأضافة كقوالب والذي تضمن المستوى T1 (طبقة واحدة من TSP بين طبقتين من اليوريا) و T2 (طبقة واحدة من اليوريا بين طبقتين من TSP), العامل الثاني كان عمق الأضافة وهو بمستويين (5سم و 10سم ورمز لهما D1 و D2), وكان العامل الثالث هو معدل الأضافة وكان بثلاث مستويات (1.0 و 1.25 و 1.50 مرة بقدر سماد N و P الموصى به للباقلاء ورمز لهم R1 و R2 و R3). زرعت الباقلاء وأخذت معايير النمو الأتية : إرتفاع النبات, عدد الآوراق, الوزن الجاف للنبات, محتوى الكلوروفيل, المساحة الورقية, تركيز N و P في النبات. أظهرت النتائج بأن المعاملات الآتية : T1 من الخلط (قالب رقم 1) , و D1 و R2 تفوقت معنوياً على بقية المعاملات في كافة معايير النمو وفي تراكيز N و P في النبات. تفوقت معاملة التداخل الثلاثي T1D1R2 معنوياً على بقية المعاملات بقيم بلغت 60.99 سم و 442.7 ورقة لكل نبات و 20.32 سم2 و 63.87 سباد و 5.59 غم لكل نبات و 5.55% و 0.27% لصفات إرتفاع النبات وعدد الأوراق لكل نبات والمساحة الورقية ومحتوى الكلوروفيل والوزن الجاف للنبات و تركيز N و P في النبات, على التوالي.

كلمات مفتاحية: السوبرفوسفات، اليوريا، خلط الأسمدة، الترب الجبسية.

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INTRODUCTION

Gypsiferous soils in Iraq comprise 88,000 km^2 (20%) of the total area (15), and it is characterized by a reduced fertility. These soils are poor in organic matter content which ranged between (0.2 – 1.0%) in surface horizons to 0.2% in sub horizons, therefore total nitrogen content is low and it barely reach 21 mg kg^{-1} (4). Gypsiferous soils are also suffer from a shortage in available phosphorus which ranged between 3- 5 mg kg^{-1} because of the chemical transformations which act towards the formation of more stable compounds due to the high soluble calcium concentrations (35). Therefore, management of such soils require more attention to fertilizer application especially for nitrogen and phosphorus. One of the common methods of fertilizer application is through the dual application of nitrogen (N) and phosphorus (P) fertilizers (19). The most common and widely used N and P fertilizers are urea and triple superphosphate. Tisdale and Nelson,1975 (33) stated that when a soluble phosphate and ammonium nitrogen are applied together in a band, plant roots proliferate extensively in that area. Combining urea with a P fertilizer offers several advantages, uniform and simultaneous application of the two nutrients, and reduced distribution costs (11). The agronomic effectiveness of urea could be improved when combined in an intimate mixture with triple superphosphate (TSP) (12), or single superphosphate (SSP) (1). The acidic properties of TSP and its reaction with urea in fertilizer- soil microsites could reduce the toxicity of banded urea due to free ammonia generated during hydrolysis of urea (13). Unfortunately, urea is not recommended to be granulated or blended with TSP due to incompatibility with TSP (27). Frazier et al.,1967 (17) attributed the undesirable properties of mixtures of urea and TSP to the formation of $CO(NH_2)_2 – H_3PO_4$ and $CaHPO_4$, based on the chemical composition and results of hygroscopicity tests of simulated product mixtures. Ali & Majeed, 2016 (2) stated that the ammonium source of nitrogen $NH_4{}^{+}$ -N (like urea) in the medium leads to a greater amount of dissolved phosphorus compared to a source Nitrate (NO_3^--N). There are two approaches of mixing urea and TSP, the first is compaction which is a process whereby two or more fertilizer carriers are finely ground, mixed then re aggregated by passing through a series of rollers in a compaction process and it proved superiority and efficiency in acidic soils, and the second is blending which is the dry mixing of urea and TSP (29). It is well known that urea hydrolysis could result in a temporary increase in soil pH and an accumulation of NH_4^+ (13, 22) and the increased pH and NH_4 should lead to the dissolution of organic matter, which is not favored in arid regions. From the other hand, short term localized effect of banding TSP with urea reduced soil pH increases from urea hydrolysis and reduced NH_3 concentrations in the fertilizer band, alleviating early toxicity to plant growth (14) thus added P effects were due not only to reduced NH_3 concentrations, but reduced pH, and increased NO_3/ NH_4 ratios in the soil. Banding urea with TSP increased P fertilizer uptake efficiencies and corn yields, which is probably the major advantages of banding urea with TSP mixtures. Chien et al., 1987 (7) found that urea hydrolysis can be beneficial in increasing the availability of P from phosphate rock (PR) to plants in soils having medium to high organic matter contents. Widdowson and Penny, 1969 (36) found that yield from the fertilizers containing urea phosphate were larger than from those containing superphosphate alone, and also the urea phosphate was safer than urea alone. Soil extractable P (Mehlich III), Total N, P uptake by corn, fertilizer P use efficiency and grain yield were increased by banding urea with TSP (12). It is obvious from the above review that there is a synergistic effect of N and P upon application of urea with TSP. Lu et al., 1987 (23) compared the influence of three methods of fertilizer placement (surface placement, incorporation, and deep placement) on a calcareous soil and found that Olsen P in the soil treated with urea plus TSP was higher than the soil treated with DAP and plant yields obtained with urea + SSP were higher than those obtained with DAP regardless of the method of fertilizer placement. Fertilizer placement in soil, which refer to precise application of specific fertilizer formulations close to seeds or plant roots to ensure high nutrient availability, may be a more effective alternative to broadcast application (27). Borges and Mallarino, 2001 (6) evaluated the response of corn to broadcast or deep band (15- 20 cm depth) placements in 15 site – years, and found that both placements usually were similarly effective for P, and that deep banding often was superior for K. Nkebiwe et al., 2016 (28) stated that the placement of urea and soluble P resulted in 27.3 % higher yield than broadcasting. Rose and Diaz, 2015 (31) evaluated the effects and interactions of fertilizer placement, tillage, and varieties of soybean and corn, and found that there were advantages for deep band application for soybean and broadcast application for corn.In This study broad bean will be used as a test crop because it is a promising crop in gypsiferous soils and It occupies an important place among food security crops due to its high content of protein and fiber (20) in addition to being a source of energy and its grains is considered the cheapest source of protein compared with the costly animal protein (3) as well as its importance in improving soil properties through the contribution of plants to fixing atmospheric nitrogen in symbiosis with Rhizobia bacteria (10). The objective of this study was to examine the effect of blending TSP with urea on N, P concentration in plant and growth of broad bean in a gypsiferous soil.

MATERIALS and METHODS

Preparation of the experimental field

A field experiment was conducted on a sandy clay loam soil at the fields of college of agric. - Tikrit Univ. Table 1 shows some properties of the field soil before planting which were analyzed according to the standard methods mentioned in Page et al., 1982 (30), while CEC was determined by the method of Savant (1994). The texture of the soil was Sandy Clay Loam as was determined by the method mentioned by Day (1965). The soil classified as Typic Haplogypsids. The field was prepared through reduced tillage. Experimental units were prepared in field at 3 * 2 m plots leaving 1 m between replications and between plots. The experimental design was factorial in a randomized Complete Block Design (RCBD) with three replicates.

Study factors: The study consisted of three factors, the first was type of application (briquette 1 and briquette 2 given the symbols T1 and T2), the second was application depth (5 and 10 cm given the symbols D1 and D2), and the third was application rate (1, 1.25, and 1.5 as much as N and P fertilizer recommended for broad bean given the symbols R1, R2, and R3). The number of experimental units were 36 units.

Preparation of the briquettes: The briquettes were prepared as cuboid granules by putting a cellophane film to take a cuboid shape corresponding to the weight of the fertilizer (NP) required for each plant and three rates were made for each briquette (1, 1.25, and 1.5 as much as NP fertilizer recommended for broad bean) as mentioned earlier. Briquette no. 1 was made by putting one layer of TSP between two layers of urea in the cuboid shape cellophane container and were glued by acacia (Arabian gum) at a ratio (1: 1 acacia: water) and were let dry for overnight. Briquette no. 2 was made by putting one layer of urea between two layers of TSP in the cuboid shape cellophane container and were glued by acacia (Arabian gum) at a ratio (1: 1 acacia: water) and were let dry for overnight.

Fertilizer application: Fertilizer NP briquettes were calculated on the basis of plot area and this quantity was distributed as one briquette per plant in which depth of application was taken into consideration where the briquettes were placed 5 cm beside the seed while the depth was variable (5 and 10 cm). The recommended fertilizer rate was 100 kg N ha^{-1} and 52 kg P ha^{-1}, while potassium was applied as potassium sulphate equally to all experimental units at 33 kg K ha^{-1} (26). Fertilizers were applied as a single dose upon planting.

Broad bean planting: The variety used was the Spanish variety Luz De Otono. The seeds were grown at rows at 35 cm between plants and 75 cm between rows on 15 Oct 2017. Two seeds were placed at a 5 cm depth and a distance of 5 cm from the fertilizer zone (which contain the assigned fertilizer briquette) and were thinned to one plant after emergence. Irrigation was achieved according to the water requirements of the plant. The first harvest of the green pods was on 9 March 2018 and the last was on 22 of April 2018, which collect 6 harvests. The yield was cumulative for the whole growing season.

Measurements and analyses: The plants were sampled for each plot and for each measurement. The following measurements were taken at the end of the season: plant height, No. of leaves, plant dry weight, N and P conc. In plant (%), and the chlorophyll content which was measured by the chlorophyll meter (Spad) by taking the average of five plants at 65 days' stage. Concentrations of N and P in plant were determined after achieving the wet digestion of the plant material by acids, according to the method proposed by Gresser method mentioned in Cresser and Parsons, 1979 (8).

Statistical analyses: Statistical analyses were carried out using procedures mentioned in the statistical Analysis System (32) and Duncan test was used to compare means at 0.05 significance level.

Table 1. Some physical and chemical properties of the soil used in the study

Property	Value	Property	Value	Property	Value
Particle size distribution ($g\ kg^{-1}$)		Available macro nutrients ($mg\ kg^{-1}$ soil)		Soluble Ions ($cmolkg^{-1}$)	
Clay	200	N	31	Ca	1.8
Silt	250	P	5.6	Mg	0.8
Sand	550	K	119.44	Na	0.17
Textural class	S.C.L			K	0.022
EC ($dS\ m^{-1}$)	2.77			Cl	0.48
pH	7.5			SO_4	1.98
Organic matter ($g\ kg^{-1}$)	2.5			HCO_3	0.33
CEC ($Cmole+\ kg^{-1}$)	15				
$CaCO_3$ ($g\ kg^{-1}$)	261				
$CaSO_4.2H_2O$ ($g\ kg^{-1}$)	44.5				

RESULTS and DISCUSSION

Plant height (cm): Table 2 shows the effect of briquette type, application depth, and application rate on plant height. The main effect of T factor was in favor of T1 over T2 with values reached 49.44 cm and 46.49 cm, respectively which means that briquette no. 1 was significantly superior over briquette no. 2. The main effect of D factor was in favor D1 treatment over D2 with values reached 49.52 cm and 46.40 cm, respectively which means that D1 was significantly superior over D2. The main effect of R factor was in favor of R2 which was significantly over R1 and R3 with values reached 42.24 cm, 54.84, and 46.81 cm, respectively, which means that the recommended dose for broad bean issued by the ministry of agriculture for the whole soils of Iraq and which is adopted by farmers in areas where gypsiferous soils are dominated is not sufficient to fulfill the plant needs of nutrients in such soils. The triple interaction was significant and the treatment T1D1R2 was significantly superior over other treatments with a value reached 60.99 cm which is the outcome of briquette no. 1 and the shallow depth and the second rate of application. The least value 41.11 cm in this interaction was for the treatment T2D2R1.

Table 2. Effect of briquette type, application depth and rate of application on plant height (cm)

		R1	R2	R3	Mean of D*T
D1	T1	H 44.01	A 60.99	E 49.26	A 51.42
	T2	I 42.29	C 53.16	F 47.41	B 47.62
	T1	J I 41.55	B 54.71	G 46.09	B 47.45
D2	T2	J 41.11	D 50.48	H 44.48	C 45.36
					Mean of D
	D1	E 43.15	A 57.08	C 48.33	A 49.52
	D2	F 41.33	B 52.60	D 45.29	B 46.40
					Mean of T
	T1	E 42.78	A 57.85	C 47.67	A 49.43
	T2	F 41.69	B 51.82	D 45.95	B 46.49
Mean of R		C 42.24	A 54.84	B 46.81	

No. of leaves

The effect of briquette type, application depth, and application rate is shown in table 3. The main effect of T factor was gained by briquette no. 1 with a value reached 351.3 leave $plant^{-1}$, which was significantly superior over briquette no. 2 which achieved 335.8 leave $plant^{-1}$. The main effect of D factor was in favor of D1 treatment (5 cm) which was significantly superior over D2 (10 cm) with values reached

349.6, 337.6 leave plant$^{-1,}$ respectively for D1 and D2. The main effect of R factor was for R2 treatment (1.5 recommended) fertilizer which was significantly superior over the two rates R1 and R3. The values were 238.6, 415.8 and 376.3 leave plant^{-1}, respectively for R1, R2, and R3. The triple interaction was significant and was recorded by the treatment T1D1R2 with a value reached 442.7 leave plant^{-1}, while the least value was recorded by the treatment T1D1R1 with value reached 232.5 leave plant^{1}.

Table 3. Effect of briquette type, application depth and rate of application on no of plant leaves

		R1	R2	R3	Mean of D*T
D1	T1	K 232.5	A 442.7	D 399.0	A 358.1
	T2	J 235.7	C 409.8	F 377.9	C 341.1
D2	T1	I 243.6	B 422.5	G 367.7	B 344.6
	T2	I 242.9	E 388.2	H 360.5	D 330.5
					Mean of D
	D1	F 234.1	A 426.3	C 388.5	A 349.6
	D2	E 243.2	B 405.3	D 364.1	B 337.6
					Mean of T
	T1	E 238.0	A 432.6	C 383.4	A 351.3
	T2	E 239.3	B 398.0	D 369.2	B 335.8
Mean of R		C 238.7	A 415.8	B 376.3	

Leaf area (cm^2)*:*

Table 4 shows the effect of briquette type, application depth and application rate on the plant leaf area. The main effect of T factor favors the significant superiority of T1 (briquette no. 1) over T2 (briquette no. 2) with values reached 15.16 cm^2 plant^{-1} and 13.5 cm^2 plant^{-1}. The main effect of D factor was not significant with values reached 14.3 and 14.4 cm^2 plant^{-1}, respectively for D1 and D2. The main effect of R factor was significant, where the treatment R2 was significantly superior over R1 and R3 with values reached 11.6, 16.9 and 14.4 cm^2 plant^{-1}, respectively for R1, R2, and R3. The triple interaction was significant and illustrating that the treatment T1D1R2 was significantly superior over the treatments with values reached 20.32 cm^2 plant^{-1}, while the least value was recorded by the treatment T2D1R1 with value reached 8.9 cm^2 plant^{-1}.

Table 4. Effect of briquette type, application depth and rate of application on leaf area (cm^2)

		R1	R2	R3	Mean of D*T
D1	T1	H 9.79	A 20.32	C 15.97	A 15.36
	T2	I 8.90	B 16.66	E 13.94	D 13.17
D2	T1	E 14.36	C 15.64	D 14.90	B 14.97
	T2	F 13.43	D 14.96	G 12.86	C 13.75
					Mean OF D
	D1	E 9.35	A 18.49	C 14.95	A 14.26
	D2	D 13.90	B 15.30	D 13.88	A 14.36
					Mean of T
	T1	E 12.08	A 17.98	C 15.43	A 15.16
	T2	F 11.17	B 15.81	D 13.40	B 13.46
Mean of R		C 11.62	A 16.90	B 14.42	

Chlorophyll content (SPAD)

The effect of study factors T, D, and R is illustrated in table 5. Where it is obvious from the main effects of these factors that treatment T1 was significantly superior over T2 in other words briquette no. 1 was superior with value reached 48.6 SPAD over briquette no. 2 which record 45.5 SPAD. The treatment D1 was also significantly superior over D2 with values reached 49.05 SPAD and 45.00 SPAD, respectively. The second rate of application which represent 1.25 of the recommended rate for broad bean was significantly superior over R1 and R3, the values were 36.00 SPAD, 57.61 SPAD, and 47.50 SPAD, respectively for R1, R2, and R3. The triple interaction treatment T1D1R2 with value reached 63.87 SPAD was significantly superior over other treatments, while the least value (32.85 SPAD) was achieved by the treatment T2D1R1.

Table 5. Effect of briquette type, application depth and rate of application on chlorophyll content (SPAD)

		R1	R2	R3	Mean of D*T
D1	T1	H 38.23	A 63.87	E D 50.34	A 50.82
	T2	J 32.85	B 60.06	E 48.93	B 47.28
D2	T1	H 37.87	C 54.61	F 46.56	B 46.34
	T2	I 35.06	D 51.88	G 44.05	C 43.66
					Mean of D
	D1	E 35.54	A 61.97	C 49.64	A 49.04
	D2	E 36.46	B 53.25	D 45.30	B 45.00
					Mean of T
	T1	E 38.05	A 59.24	C 48.45	A 48.58
	T2	F 33.96	B 55.97	D 46.49	B 45.47
Mean of R		C 36.00	A 57.61	B 47.47	

Dry matter (g plant^{-1})

Table 6 shows the effect of study factors T, D, and R on dry matter of plant. It is clear from the main effects of these factors that T1 proved to be significantly superior over T2 which means that briquette no. 1 with value reached 3.99 g was superior over briquette no. 2 which had the value 3.37 g. while for the factor D the treatment D1 was significantly superior over D2 which means that placement of fertilizer at 5 cm depth was better than 10cm for broad bean in this soil. The values attained were 4.00 g and 3.36 g, respectively for D1 and D2. When examining the factor R it was noticed that the treatment R2 (the rate 1.25 of the recommended fertilizer for broad bean) was significantly superior over R1 and R3 with values reached 2.68 g, 4.41 g, and 3.96 g, respectively for R1, R2, and R3. The triple interaction of the three factors T, D, and R shows that the treatment T1D1R2 is significantly superior over other treatments and achieved the value 5.59 g, while the least value (2.07 g) was recorded for the treatment T2D2R1 which means that the treatment T1D1R2 achieved 62% increase over the treatment T2D2R1.

Table 6. Effect of briquette type, application depth and rate of application on plant dry matter (g plant^{-1})

		R1	R2	R3	Mean of D*T
D1	T1	D E 3.21	A 5.59	B 4.32	A 4.37
	T2	E 2.95	B 4.74	D E 3.20	B 3.63
D2	T1	F 2.48	C 3.87	B 4.51	B 3.62
	T2	G 2.07	D C 3.44	C 3.81	C 3.11
					Mean of D
	D1	D 3.08	A 5.17	C 3.76	A 4.00
	D2	E 2.28	C 3.66	B 4.16	B 3.36
					Mean of T
	T1	E 2.85	A 4.73	B 4.41	A 4.00
	T2	F 2.51	C 4.09	D 3.51	B 3.37
Mean of R		C 2.678	A 4.41	B 3.96	

Nitrogen concentration in plant (%)

Table 7 illustrate the influence of study factors T, D, and R on N concentration in plant. The main effect of factor T explain that treatment T1 was significantly superior over T2 with values 3.97% and 3.46%, respectively. While the main effect of factor D reveal that treatment D1 was significantly superior over D2 with values 3.93% and 3.49%, respectively. The main effect of factor R was in favor of treatment R2 which was significantly superior over the other rates of application. The values were 2.87%, 4.60%, and 3.67%, respectively for R1, R2 and R3. The triple interaction was recorded by the treatment T1D1R2 with value 5.55% while the least value was recorded by the treatment T2D2R1 with value reached 2.40%.

Table 7. Effect of briquette type, application depth and rate of application on Nitrogen concentration in plant (%)

		R0	R1	R2	Mean of D*T
D1	T1	G F 3.21	A 5.55	C D 4.09	A 4.28
	T2	G F 3.05	E D 3.74	D 3.95	B 3.58
D2	T1	G 2.81	B 4.69	E F 3.44	B 3.65
	T2	H 2.40	C B 4.41	G F 3.19	C 3.33
					Mean of D
	D1	C 3.13	A 4.65	B 4.02	A 3.93
	D2	D 2.60	A 4.55	C 3.32	B 3.49
					Mean of T
	T1	D 3.02	A 5.12	C 3.77	A 3.97
	T2	E 2.73	B 4.08	C 3.57	B 3.46
Mean of R		C 2.87	A 4.60	B 3.67	

Phosphorus concentration in plant (%)

The influence of study factors T, D, and R on N concentration in plant is explained in Table 8. The main effect of factor T explain that treatment T1 was significantly superior over T2 with values 0.22% and 0.18%, respectively. While the main effect of factor D reveal that treatment D1 was significantly exceeded over D2 with values 0.21% and 0.19%, respectively. The main effect of factor R was in favor of treatment R2 which was significantly superior over the other two rates of application. The values were 0.15%, 0.23%, and 0.22%, respectively for R1, R2 and R3. The triple interaction was recorded by the treatment T1D1R2 with value 0.27% while the least value (0.12%) was recorded by the treatment T2D2R1.

Table 8. Effect of briquette type, application depth and rate of application on phosphorus concentration in plant (%)

		R1	R2	R3	Mean of D*T
D1	T1	F 0.18	A 0.27	B 0.25	A 0.24
	T2	G 0.16	D 0.22	F 0.19	C 0.19
D2	T1	H 0.14	C 0.24	C 0.23	B 0.21
	T2	I 0.12	E 0.20	D 0.22	D 0.18
					Mean of D
	D1	C 0.17	A 0.24	B 0.22	A 0.21
	D2	D 0.13	B 0.22	B 0.23	B 0.19
					Mean of T
	T1	E 0.16	A 0.26	B 0.24	A 0.22
	T2	F 0.14	C 0.21	D 0.20	B 0.19
Mean of R		C 0.15	A 0.23	B 0.22	

We adopt the blending technique in this study because of the restraints on the use of compacted urea plus TSP combinations due to the formation of the reaction product that forms an adduct which is viscous saturated solution that makes the mixture wet and sticky (17). From the review of results of this study it is revealed that the treatment T1 was dominated over the treatment T2 in all the growth parameters and N, P concentration in plant, this may be due to the beneficial effect of urea which surround the TSP granules in briquette no. 1, this effect may include urea hydrolysis and subsequent pH increase, NH_4^+ accumulation and dissolution of organic matter during urea hydrolysis, which result in a reduced P fixation and enhanced P diffusion in soil, which is in accord with results of Ouyang et al., 1999 (29) study in acid soils, which aims to increase P fertilizer efficiency in acid soils by compacting or blending TSP with urea. It is clear that the effect of urea in briquette no. 1 is prevalent over the effect of TSP which surround urea in briquette no. 2. While in briquette no. 2 the TSP is surrounding urea and because of the acidic properties of TSP which slightly inhibit the above mentioned action urea, this acidic action is the basis in mixing urea with TSP i.e. to reduce the toxicity of banded urea due to free ammonia generated during hydrolysis of urea (14). This means that there are an interaction of different reactions taking place in the intimate proximity of TSP – Urea and the sum of the reactions tends to favor the urea effect because urea hydrolysis could be beneficial in increasing the availability of P from TSP. Results of the factor D (depth of application) was in favor of D1 treatment (5 cm) in all the growth parameters and N, P uptake studied. The superiority of D1 treatment may be due to the urea effect because the depth of urea fertilizer placement is the most effective compared to the depth of P fertilizer placement, especially when N is placed at a shallow depth, this may be explained by nitrogen being a mobile nutrient in soil in contrast to phosphorus (19; 21). Most references assure that plant growth did not respond to the depth of P fertilizer placement (5) for corn and Mallarino and Borges, 2006 (23) for soybean. Our results are in agreement with Hansel et al., 2017 (18) who found that the shallow band applied fertilizer (5 *5 cm) to side and below seed was the best over surface and deep band applications. From the other hand there is an evidence that deep banding of P may increase both early growth of corn but it did not translate into higher grain yield (24; 6). While in their study about P placement methods Fernandez and Schaeter, 2012 (16) compared broadcast application of P with deep banded application for corn and soybean and found that subsurface banding reduced P levels in the surface and increased them at the point of application or deeper with the highest rate, while broadcast application increased surface levels. It is revealed from results of the effect of R factor (rate of fertilizer application) on growth parameters and N, P uptake that the treatment R2 was significantly superior over other treatments (R1 and R3). The results assure that the recommended rate of application of N and P for broad bean (R1) is not suitable for this crop in gypsiferous soils, this may be due to the chemical and fertility characteristics of these soils which is poor in most nutrients and in organic matter (4). The increase in R2 values for all the growth parameters studied explain that these soils need more amounts of fertilizer N and P to fulfill crop needs. The increase of R2 over R1 reached 30%, 74%, 45%, 60%, 65%, 60%, and 52% for plant height, no. of plant leaves, leaf area, chlorophyll content, dry weight of plant, N concentration, and P concentration, respectively. This is in accord with results of Ouyang et al., 1999 (29); Fan and Mackenzie,1995 (14). The treatment R3 was significantly superior over R1 but it was significantly lower than R2, so it must not be adopted due to the unjustified waste of nutrient application which was not reflexed on the plant parameters (27).

CONCLUSION

Two methods of blending urea with TSP for broad bean fertilization in a gypsiferous soil. It was found that method no.1 (briquette no. 1) which include a layer of TSP surrounded by two layers of urea was significantly effective in increasing values of plant growth parameters and plant N, P concentration. It was also found that placing the blended fertilizer at 5 cm depth was significantly superior over the 10 cm depth for all the growth parameters and plant N, P concentration. The fertilizer recommendation currently followed for broad bean fertilization was found unsuitable for this crop in gypsiferous soils. The second level which was one and quarter fold (1.25) as much as the current recommendation was superior in all growth parameters and plant N, P concentration, while the third level which is (1.50) as much as the current recommendation caused a decrease in growth parameter values relative to the second rate (1.25).

REFERENCES

1**.** Aasamae, E., E. Arumeel, M. Einard, and M. Veiderma. 1993. Obtaining granular NPK fertilizers from single superphosphate and Urea. Fert. Res. 35: 161- 167

2. Ali, N. S. and N. H. Majeed. 2016. Rhizosphere microorganisms and phosphorus availability for plants. The Iraqi J. of Agric. Sci. 47 (2): 635- 645

3. Al-Selawy, R. L. A., A. H. Saudi, and K. Al- Fartoosi. 2018. Effect of spray with concentrations of Zinc on growth and yield of two broad bean (*Vicia faba L.*) cultivars. J. of Thi-Qar Univ. for Agric. Res.7: 1-12

4. Al-Tai, T. A. A. 2011. Management of Gypsiferous Soils. Al-Hilal Dar and Library for Printing and Publishing. Beirut. Lebanon. pp: 27

5. Bordoli, J. M. and A. P. Mallarino. 1998. Deep and shallow banding of phosphorus and potassium as alternatives to broadcast fertilization for No- Till corn. Agron. J. 90: 27- 33

6. Borges, R., and A. P. Mallarino. 2001. Deep banding phosphorus and potassium fertilizers for corn managed with ridge tillage. Soil Sci. Sco. Am. J. 65: 376- 384
7. Chien, S. H., D. Sompongse, J. Henao, and D.T. Hellums. 1987. Greenhouse evaluation of phosphate availability from compacted phosphate rocks with urea or with urea and triple superphosphate. Fert. Res. 14: 245- 256
8. Cresser, M. S. and J. W. Parsons. 1979. Sulphuric- Perchloric acid of digestion of plant material for determination of nitrogen, phosphorus, potassium, calcium and magnesiu. Analytical Chimica Acta. 109: 431- 436
9. Day, P. R. 1965. Particle fractionation and particle analysis. P. 545- 567. In: C. A. Black et. Al. (ed.)Methods of Soil Analysis, Part 1. Agronomy 9: ASA and SSSA, Madison, WI. USA
10. Dhary, S. I. and M. H. K. Al – Baldaqi. 2017. Response of different varieties of Faba bean to plant source organic fertilizers> The Iraqi J. of Agric. Sci. 48(4): 1141- 1147
11. Fan, M. X., A. F. Mackenzie, and H. D. Blenkhorn. 1996. A modified urea based NP fertilizer: UREA - TSP- MAP combinations. Fert. Res. 45: 217- 220
12. Fan, M. X. and A. F. Mackenzie. 1994. Corn yield and phosphorus uptake with banded urea and phosphate mixtures. Soil Sci. Soc. Am. J. 58: 249- 255
13. Fan, M. X. and A. F. Mackenzie. 1993. Urea and phosphate interactions in fertilizer microsites: Ammonia volatilization and pH changes. Soil Sci. Soc. Am. J. 57: 839- 845
14. Fan, M. X. and A. F. Mackenzie. 1995. The toxicity of banded urea to corn growth and yield as influenced by triple superphosphate. Can J. of Soil Sci. 75: 117- 122
15. FAO. 1990. Management of gypsiferous soils. Bulletin 62. FAO. Rome. Italy.
16. Fernandez, F., and D. Schaefer. 2012. Assessment of soil phosphorus and potassium following real time kinematic –guided broadcast and deep – band placement in Strip – till and No - till. Soil Sci. Soc. Am. J. 76: 1090- 1099
17. Frazier, A. W., J. R. Lehr, and J. P. Smith. 1967. Urea – monocalcium phosphate, a component of mixed fertilizers. J. Agric. Chem. 15: 345- 350
18. Hansel, F. D., D. A. Ros Diaz, T. J. C. Amado, and L. M. Rosso. 2017. Deep banding increase phosphorus removal by soybean grown under No- Tillage production systems. Agron. J. 109(3): 1091- 1097
19. Havlin, J. L., D. Beaton, S. L. Tisdale, and W. L. Nelson. 2005. Soil Fertility and Fertilizers. 7th ed. Prentice Hall. New Jersey. Pp: 183.
20. Jasim, A. H., H. M. Rashid, and M. M. Ghani. 2016. Effect of foliar nutrition of phosphorus and potassium on vegetative growth characteristics and yield of broad bean. Euphrates J. of Agric. Sci. 8(3): 50- 55
21. Khairul Alam, M. D., Richard W. Bell, Nazmus Salahin, Shahab Pathan, A.T.M.A.I. Mondol, M.J. Alam, M.H. Rashid, P.L.C. Paul, M.I. Hossain and N.C. Shil. 2018. Banding of fertilizer improves phosphorus acquisition and yield of zero tillage maize by concentrating phosphorus in surface soil. Sustainability. 10: 1- 24.
22. Kissel, D. E., M. L. Cabrera, and R. B. Ferguson. 1988. Reactions of ammonia and urea hydrolysis products with soil. Soil Sci. Soc. Am. J. 52: 1793- 1796
23. Lu, D. Q., S. H. Chien, J. Henao, and D. Sompongse. 1987. Evaluation of short - term efficiency of diammonium phosphate versus urea plus single superphosphate on a calcareous soil. Agron. J. 79: 896- 900
24. Mallarino, A. P., J. M. Bordoli, and R. Borges. 1999. Phosphorus and potassium placement effects on early growth and nutrient uptake of No-Till corn relationship with grain yield. Agron. J. 91: 37- 45
25. Mallarino, A. P. and R. Borges. 2006. Phosphorus and potassium distribution in soil following long term deep – band fertilization in different tillage systems. Soil Sci. Soc. Am. J. 70(2): 702- 707
26. Ministry of Agriculture and Irrigation. 1992. Chemical fertilizer Use Manual. Central Committee of Fertilizers. Pp. 23
27. Mortvedt, J. J., L. S. Murphy, and R. H. Follet. 1999. Fertilizer Technology and Application. Meister Publishing Co. Ohio. USA. Pp. 220
28. Nkebiwe, P. M., M. Weinmann, A. Bar-Tal, and T. Muller. 2016. Fertilizer placement to improve crop nutrient acquisition and yield:

A review and meta- analysis. Field Crops Res. 196: 389- 401
29. Ouyang, D. S., A. F. Mackenzie, and M. X. Fan. 1999. Availability of banded triple superphosphate with urea and phosphorus use efficiency by corn. Nutr. Cycl. In Agroecosystems. 53: 237- 247
30. Page, A. L., R. H. Miller, and D. R. Keeney. 1982. Methods of soil analysis. Part 2. Second Ed. Agronomy Series 9. Am. Soc. of Agron. Madison. WI
31. Rose, A. T., and D. A. Ruiz Diaz. 2015. Fertilizer placement and tillage interaction in corn and soybean production. Kansas State Univ. Agric. Exp. Stat. & Coop. Ext. Service. Kansas Fert. Res. 2015 Tech. Report
32. SAS Institute Inc. 2002. Statistical Analysis System. SAS Inc. Cary, NC
33. Tisdale, S. L., and W. L. Nelson. 1975. Soil fertility and fertilizers. Second Edition. The Macmillan Company. New York. Pp. 239
34. Savant, N.K. 1994. Simplified methylene blue method for rapid determination of cation exchange capacity of mineral soils. Soil Sci. Plant Anal. 25: 3357-3364
35. Van – Alphen, J. D. and F. D. Rios Romero. 1971. Gypsiferous soils. Notes on characteristics and management. Inst. L. and Rec. Improv. Bulletin12. Wageningen, The Netherlands. Pp. 165
36. Widdowson, F. V, and A. Penny. 1969. Effects on barely and kale of NPK fertilizers containing differing proportions of urea and ammonium nitrate, and either triple superphosphate or mono – urea phosphate. The J. of agric. Sci. 73: 125- 132.