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COMPACTION OF METAL SALT UREA COMPLEXES WITH SINGLE SUPERPHOSPHATE AND THEIR EFFECTS ON RADISH PLANT

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ABSTRACT

A series of laboratory and greenhouse experiments were conducted to evaluate the compaction of metal salt urea with monocalcium phosphate (MCP) to prepare urea-based fertilizers that contain monocalcium phosphate and still maintain good physical properties during storage. Results revealed that minimizing the hydrated water was observed from compacted metal salt urea with MCP. However a slightly increase in the free water content for the urea + MCP; indicating the replacement of the hydrated water of MCP. H_2O by the urea. Data also showed that the compacted metal salt urea with MCP resulted in a reduction of urea hydrolysis, total inorganic nitrogen and NH_3 volatilization than compacted urea with MCP during the incubation periods. Results showed that the release of phosphours from different products varied depending on some physical, chemical characteristics of the materials. The reaction with MCP to form the adduct complexing metal salts with MCP increase of these variation in the releaseable-P in the soil. The addition of compacted metal salt urea with MCP at any ratio improved the characterization of metal salt urea complexes comparing with other treatments. Results also showed that the availability fraction of Fe and Mn in the treated soil with $Fe(urea)_6\,SO_4$.MCP or $Mn(urea)_4SO_4$. MCP, tended to increase as compared with compacted urea + MCP. This result may be due to the formation of stable complexes with Fe and Mn. These process may creat suitable condition to maintain both fractions in available forms through increasing its solubility products. The addition of $Fe(urea)_6\ SO_4$ or $Mn(urea)_4\ SO_4$ without compaction with MCP the fresh and dry weight of shoot and root of radish plant were significantly increased as compared with urea compacted with MCP. However the addition of compacted urea with MCP was a remarkable effect on root and shoot of radish plant as compared with urea alone. It was noticed that the addition of Fe $(urea)_6\ SO_4$ or Mn $(urea)_4\ SO_4$ enhanced the utilized of N, P, K, Fe and Mn uptake through improving the management practices of nutrient supply. Whereas the application of compacted Fe $(urea)_6\ SO_4$ or Mn $(urea)_4\ SO_4$ with MCP were more pronounced effect on the N, P, K, Fe and Mn uptake. Generally, the use of compacted metal salt urea complexing with MCP may offers some advantages such as, reduction in urea hydrolysis and/or NH_3 volatilization, improvement of seed germination and supply of micronutrients to soils.

Keywords : Metal salt urea complexes, urea hydrolysis, $(NH_4 + NO_3)$ N free water content, NH_3 volatilization, P, Fe, Mn, radish plants.

INTRODUCTION

In recent years, urea has become the major source of nitrogen fertilizer in the developing countries. However, urea should not be cogranulated or blended with single superphosphate (SSP) or triple superphosphate (TSP) in products that are to be stored for an appreciable length of time unless the superphophate is exceptionally dry (Hignett, 1979 and Hagin & Harrison, 1993). The monocalcium phosphate monohydrate (MCP. H_2O) in superphosphate reacts with urea to form an adduct and release the hydrated water (Harrison & Hedley, 1987 and Menon & Chien, 1990).

$4\ CO(NH_2)_2 + Ca(H_2PO_4)_2.H_2O \rightarrow Ca(H_2PO_4)_2.4CO(NH_2)_2 + H_2O$

Because of this reaction, the products become wet and sticky or severely caked during storage (Fan et al., 1996).

Recently, some metal salt-urea complexes have been successfully prepared (Atkisson, 1981; Lupin & Peters, 1984 and El-Aila et al., 2002). Since the urea can be effectively complexed with certain metal salts to form new anhydrous coordination complexes, it may be possible to avoid the release of water from the MCP. H_2O. This approach may make it possible to prepare urea-based fertilizers that contain superphosphate and still maintain good physical properties during storage. Such products may also offer other advantages; reduction in urea hydrolysis and/or NH_3 volatilization (Lewis and Slater, 1979); improvement of seed germination, and at the same time supply of micronutrients to soils (El-Aila et al., 2000 and 2002).

The objective of this study was to evaluate phosphorous availability from single superphosphate compacted with metal salt urea complexes and their effects on radish plant.

MATERIALS AND METHODS

Preparation of metal salt urea-single superphophate :

The technical grade of urea from industry (El-Nasr Company) and the same grade of single superphophate (Abou Zaable Company) have been used for the experiment. The metal salt urea complexes were prepared as described previously by (El-Aila et al., 2002) Metal salt urea complexes were incorporated with single superphosphate ($MCP.H_2O$) produced by a hydraulic pressure machine from a homogeneous mixture containing 100, 50, 66.66 wt% metal salt urea and 0, 50, 33.33 wt% superphosphate as described in table (1). The size of pellets was characterized by, D = 10 mm and H = 10 mm. Single pellets of urea with superphosphate at the same ratio were also investigated for this studies. The pelletes were placed in sealed bottles for storage at room temperature at different time intervals 1, 7, 14, 28, 45, 56 and 70 days. A single tablet of each material was taken out of the bottle and was ground to powder for free water measurement. Free water content was determined by the method described by AOAC (1980).

Table (1) : Calculated nutrient content in the compaction of metal salt urea with or without superphosphate :

N-source	Urea : MCP	N%	P%	Fe%	Mn%
Fe (urea)$_6$ SO_4	1 : 0	32.2	-	6.0	-
Fe (urea)$_6$ SO_4.MCP	1 : 1	16.0	7.75	6.0	-
Fe (urea)$_6$ SO_4.MCP	2 : 1	21.4	5.16	6.0	-
Mn (urea)$_4$ SO_4	1 : 0	37.3	-	-	6.0
Mn (urea)$_4$ SO_4.MCP	1 : 1	18.65	7.75	-	6.0
Mn (urea)$_4$ SO_4.MCP	2 : 1	24.8	5.16	-	6.0
Urea. MCP	1 : 1	23.3	7.75	-	-
Urea. MCP	2 : 1	30.6	5.16	-	-
Urea	1 : 0	46.0	-	-	-

Laboratory experiment :

a. Incubation experiment :

Three hundred grams of 2mm sieved air dry soil. The characterization of the investigated soil were 89.70, 5.25 and 5.05% for sand, silt and clay respectively, pH 8.01, E.C. 0.46 dsm^{-1} organic matter 0.11%, $CaCO_3$ 2.2%, total nitrogen 0.012%, available phosphours and iron were 15.6 and 10.6 ppm respectively. Soil were treated with compacted of metal salt urea complexes with single superphosphate (MCP) at a rate of 250 mg N Kg^{-1} in wide mouth 400 ml plastic containers. The fertilizers were used as follows:

N-source	Urea : MCP	N-source	Urea : MCP
Fe $(urea)_6$ SO_4	1 : 0	Mn $(urea)_4$ SO_4. MCP	2 : 1
Fe $(urea)_6$ SO_4. MCP	1 : 1	Urea. MCP	1 : 1
Fe $(urea)_6$ SO_4. MCP	2 : 1	Urea. MCP	2 : 1
Mn $(urea)_4$ SO_4	1 : 0	Urea	1 : 0
Mn $(urea)_4$ SO_4. MCP	1 : 1		

Treatments were replicated and kept under laboratory conditions, moisture content was maintained at 60% of water holding capacity through the incubation periods. Samples were taken at intervals of 1, 3, 7, 14, 28, 42, 56 and 70 days. Determinations of pH, E.C., NH_4-N, NO_3-N, urea-N, P, Fe and Mn as described by Bremner and Mulvaney (1982) and Black (1982) respectively.

b. Ammonia volatilization :

One hundred of air dried soil were mixed with 500 mg N Kg^{-1} placed in volatilization conical flask as described by Abou Seeda (1997) and sealed. Water loss due to evaporation were reinstated during the incubation periods. Sweep air was trapped in (2% H_3BO_3) volatilization of ammonia was determined according to the method described by Black (1982).

Biological experiment:

Pot experiments were conducted at the Soil and Water Use Dept. National Research Centre. Eight Kg. of air dried soil were packed in plastic pots with a height of 30 cm and a diameter of 25 cm. The compacted of metal salt urea complexes with single superphosphate were applied as previously mentioned.

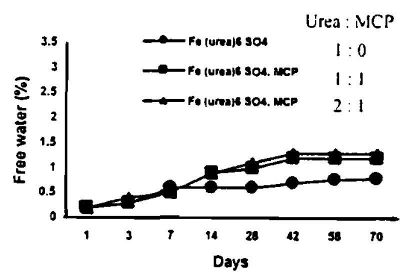
Nitrogen, phosphorus, iron and manganese were applied at rates of 40, 25, 6 and 6 mg kg^{-1} of metal salt urea complexes MCP. However the urea, superphosphate, ferrous sulphate, manganese sulphate were used as control one. Potassium and zinc were applied at a rate of 40 and 6 mg kg^{-1} as potassium and zinc sulphate. Radish plants were used as a test plants, seeds were planted; after 10 days of plantation, plants were thinned to four plants per pot. The experiment was laidout in a completely randomized block design with three replicates. Samples of plants were taken after one month and at maturity stage. Samples were separated into leaves and roots, fresh and dry weight were recorded. Total-N in shoots and roots were determined by the kjeldhal method described by Bremner and Mulvaney (1982). Phosphorus, potassium, iron, and manganese were determined according to the method described by Cottenie et al. (1982).

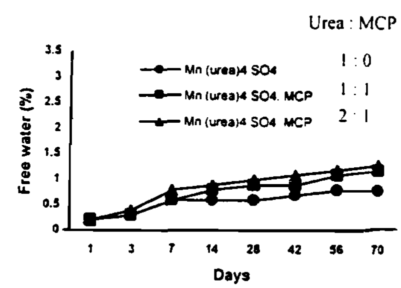
RESULTS AND DISCUSSION

Free water content of fertilizer products during storage :

The effect of compacted metal salt urea with single superphosphate (MCP) on free water content of fertilizer product during storage are shown in Fig. (1). It was observed that the free water content of the urea + MCP at a ratio of 1 : 1 or 2 : 1 were higher than the other products particularly during the 10 weeks of the storage period. This results may be due to the release of hydrated water from MCP. H_2O during the reaction with urea to produce the adduct $Ca(H_2PO_4)_2.4CO(NH2)_2$. Results also showed that minimizing the hydrated water was observed from compacted metal salt urea with MCP. This result may explained either stability constant or, urea molecule, which was no longer free to replace the hydrated water of MCP.H_2O. Bolan *et al.* (1990) indicated that compaction or metal salt urea with MCP (Produce) granules with good physical characteristics due to decreasing the hygroscopicity and increasing the strength of the granules by heating generated by the reaction of acid and rock phosphate.

It was noticed that a slightly increase in the free water content for the urea + MCP, indicating the replacement of the hydrated water of MCP. H_2O by the urea. However compacted metal salt urea with MCP.H_2O decreased the free water content (Fig. 1) indicates the urea molecule was effectively protected during the reaction with MCP. H_2O to form the adduct.





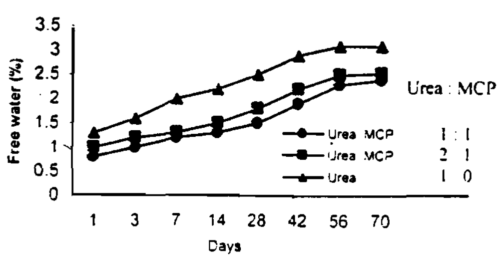


Fig. (1) : Effect of compacted metal salt urea with MCP on free water content (%) during the incubation periods

Soil reaction :

Fig. (2) observed that the addition of metal salt urea complexing slightly increased the soil pH particularly at the beginning of the incubation as compared with the other treatments. However the addition of urea. MCP at any ratio was more pronounced effect on the soil pH particularly at the first week of the incubation period than other treatments. This result may be due to the acidic properties of phosphatic fertilizer during the reaction with metal salt urea. Fan et al. (1996) reported that the reaction of urea granules with monocalcium phosphate (MCP) influence on the soil pH, due to the acidity properties of the compenent particularly (MCP). They stated that such process would reduce the toxicity of free ammonia generated during the hydrolysis of urea.

It was noticed that increasing the ratio of urea : MCP influenced on the soil pH during the incubation period. The ability of compacted urea + MCP to change the soil pH was more pronounced than Fe $(urea)_6$ SO_4. MCP and/or Mn $(urea)_4$ SO_4. MCP at any ratio of urea : MCP.

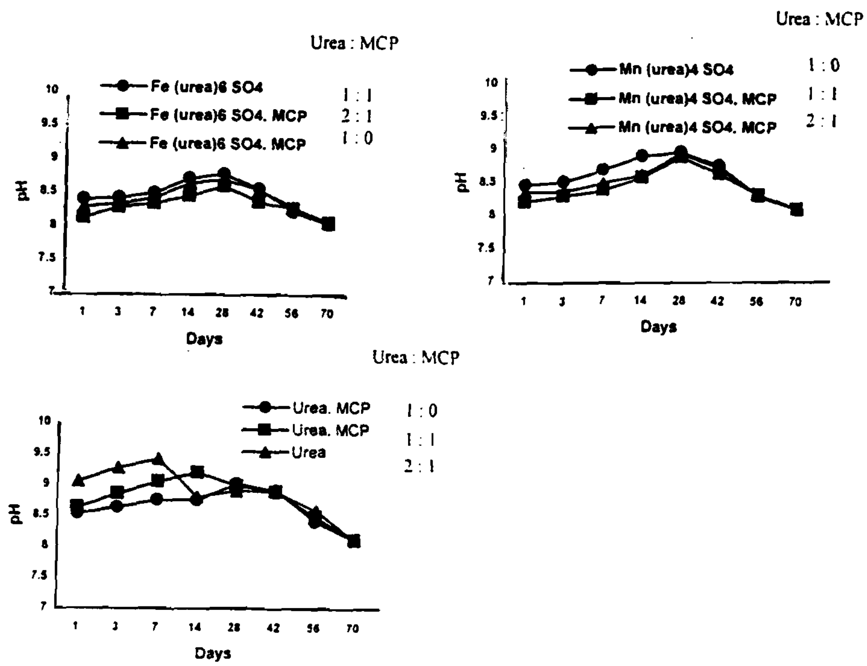


Fig. (2) : Effects of compacted metal salt urea with MCP on the soil pH during the incubation periods.

The addition of Fe (urea)$_6$ SO_4. MCP or Mn (urea)$_4$ SO_4. MCP at a ratio of (1 : 1) decreased the soil pH by about 0.94 and 0.86 units at the beginning of the incubation period comparing with urea alone. It was observed that the application of Fe (urea)$_6$ SO_4. MCP and/or Mn (urea)$_4$ SO_4. MCP at a ratio of (1 : 1) decreased the soil pH by about 0.76 and 0.64 units as compared with urea. MCP at a ratio of (2 : 1) particularly after two weeks of incubation.

Fig. (3) illustrated that the addition of urea without MCP gave the highest value of the soil E.C. through the incubation particularly at the beginning of the experiment, and gradually increased up to 14 days of the incubation period. However the addition of compacted urea with MCP slightly decreased the E.C. of soil as compared with urea alone. Addition of metal salt urea without MCP was more pronounced effect on the E.C. of the soil as compared with the addition of compacted metal salt urea with MCP.

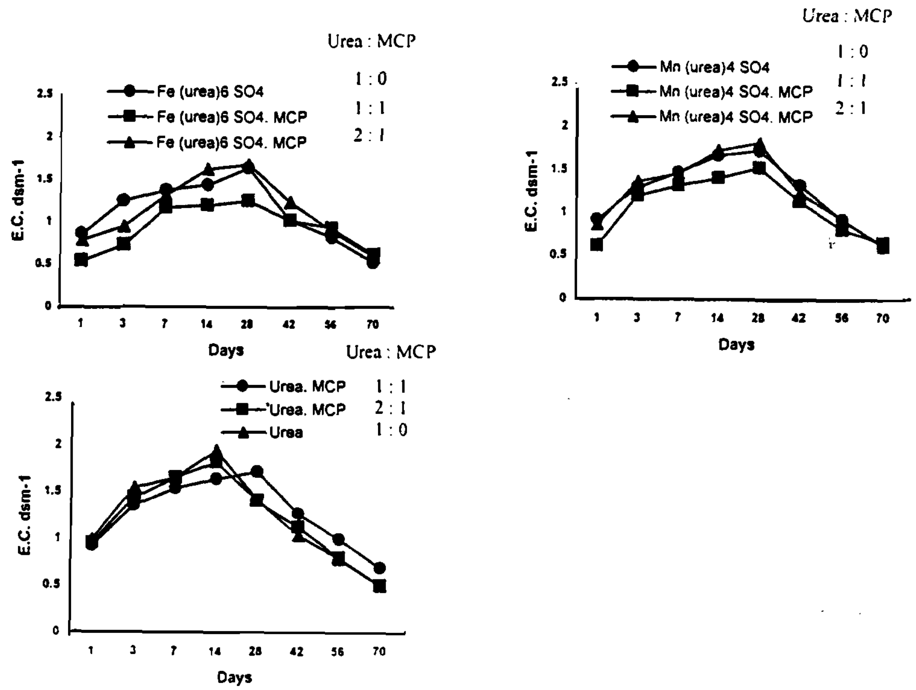


Fig. (3) : Effect of compacted metal salt urea. with MCP on the electrical conductivity of the soil (E.C.dsm^{-1}).

Results also showed that Mn $(urea)_4$ SO_4 was remarkable effect on the E.C. of soil than Fe $(urea)_6$ SO_4.

Concerning of metal salt urea with MCP it was observed that a reduction in the E.C. of soil due to the addition of compacted Fe $(urea)_6$ SO_4. MCP at ratios of 1 : 1 and 2 : 1 was about 46 and 21% respectively at the first day as compared with urea without MCP. After 14 days of the incubation the percentage of reduction in E.C. of the soil for both Fe $(urea)_6$ SO_4. MCP and Mn $(urea)_4$ SO_4. MCP at ratios of 1 : 1 and 2 : 1 were 26.0, 10.4% and 14.0, 4.9% as compared with compacted urea with MCP at ratios of 1 : 1 and 2 : 1 respectively. The beneficial effects of the compaction of metal salt urea with monocalcium phosphate inhibit the evolution of the created ammonia formed from the hydrolysis of urea which could be increased the electrical conductivity (E.C) of the investigated soil, and furthermore gradually increase in the presence of MCP.

Urea-N transformation :

Data in Fig. (4) revealed that urea without compaction with MCP gave the highest value of urea hydrolysis in the investigated soil. The peak of urea hydrolysis was observed during the first three days. Data also showed that the compacted metal salt urea with MCP resulted in a reduction of urea hydrolysis than compacted urea with MCP during the incubation period. The differences between two types of complexing urea production were, probably due to the improvement between the contact metal salt urea and MCP through the pressure process where the water between intermolecular space was limiting (Stumpe et al., 1984).

Data showed that the application of Mn $(urea)_4$ SO_4. MCP at ratio of (2 : 1) gave the highest value of urea-N, followed by $Fe(urea)_6SO_4$.MCP at the same ratio. Similar trend was observed in case of $Fe(urea)_6SO_4$.MCP at a ratio (1 : 1) for given the best release of urea during the incubation period. Such results may be due to the ability of $Fe(urea)_6SO_4$ to form stable complexes with MCP and also regulate the hydrolysis of urea (Fan et al., 1996).

Data also showed that the effectiveness of MCP for reducing urea-N have been greater when the metal salt urea complexing was applied at a ratio of (1 : 1), the reduction was about 49.3 and 44.1% for $Fe(urea)_6SO_4$.MCP and $Mn(urea)_4SO_4$.MCP rather than in compacted urea. MCP after one week. This was probably due to the effect of micronutrients which apeared to be useful in decreasing the hydroscopicity and increasing the strength of the granules to more intimate contact between the two fertilizers when applied as a compacted (Aasamae et al., 1993).

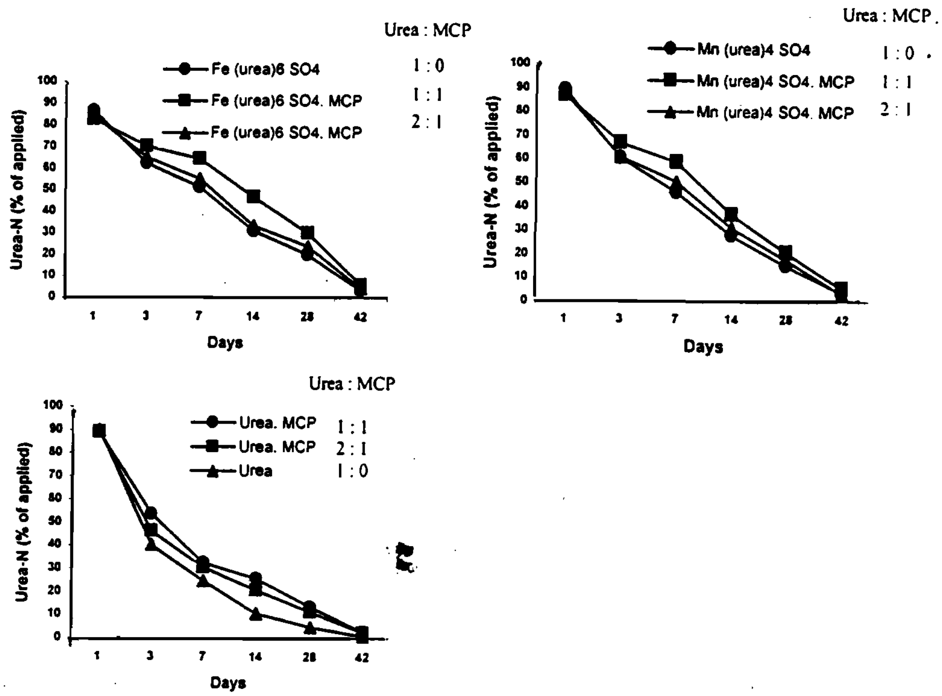


Fig. (4) : Effect of compacted metal salt urea with MCP on urea hydrolysis during the incubation periods.

Total inorganic-N :

Fig. (5) illustrates the released amounts of inorganic nitrogen from compacted metal salt urea with monocalcium phosphate through the incubation period. It was noticed that the addition of compacted urea with MCP showed a high amounts of total inorganic nitrogen released particularly during the two weeks of the incubation, this fraction were gradually diminished up to 70 days of incubation period. It probably due to the reaction of $CO\ (NH_2)_2$ with $Ca\ (H_2PO_4)_2$ to form $Ca(H_2PO_4)_2.{}_4CO(NH_2)_2$. as the major solid-phase, which is wetted by a saturated liquid phase in which the solvent is the hydrate water released from the $Ca(H_2PO_4)_2.H_2O$ (Kononov et al., 1988).

Data also showed that the application of compacted metal salt urea with MCP was more effective for regulation the total inorganic-N during the incubation. Considerable amounts of nitrogen released increased during the incubation period. This phenomenon may be due to the improvement on some physical properties of the fertilizer product which can effect on the kinetic mechanisms of the releasable fraction of inorganic nitrogen that can affected by the solubility of the pellets in the soil as reported by (Fan and Mackenzie, 1994).

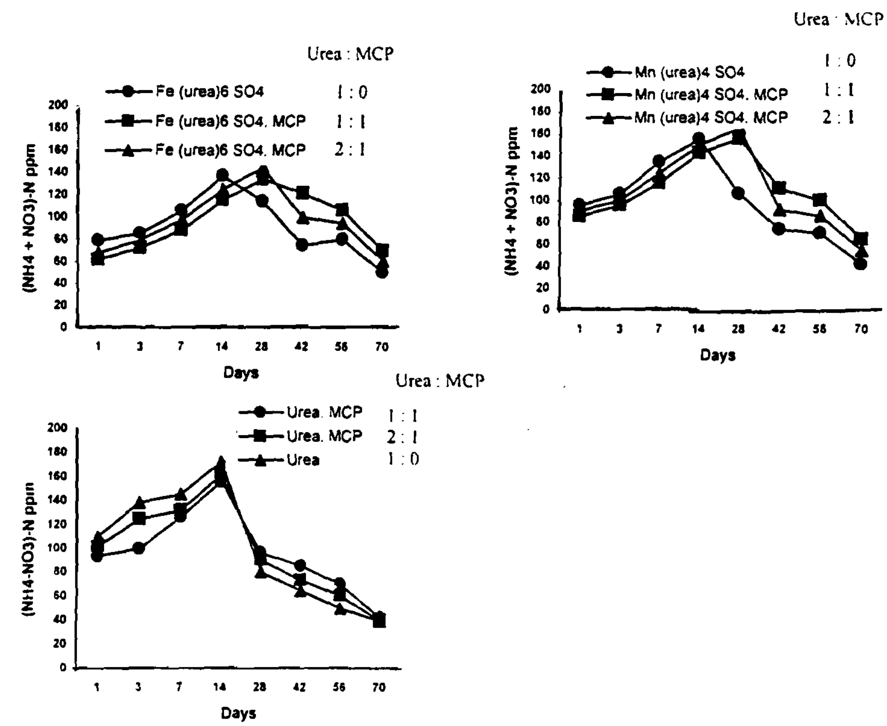


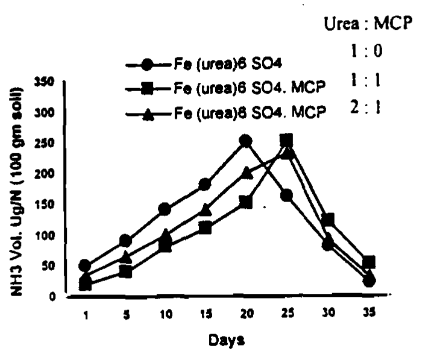
Fig. (5) : Effect of compacted metal salt urea with MCP on the total inorganic-N during the incubation periods.

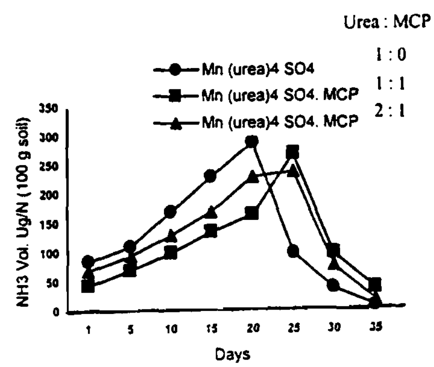
It was noticed that the rate of release for compacted metal salt urea with MCP increased with time up to 28 days of incubation. This results suggested that compaction of metal salt urea with MCP may have increased interaction between urea and MCP in the soil, that reduced the release of total inorganic-N from the hydrolyzed urea (Aasamae et al., 1993).

NH_3 volatilization :

Ammonia volatilization µg N/100g soil (Fig. 6) with time as influenced by compacted urea complexing with MCP noticed that application of urea granules stimulated NH_3-losses and ranged between 150 and 300 µg N/100g soil during 15 days of incubation period. However after this period the NH_3 losses were declined gradually up to the end of incubation. Similar results were noticed by El-Aila and Abou Seeda (1996).

It was noticed that the addition of Fe $(urea)_6$ SO_4 and/or $Mn(urea)_6SO_4$ without MCP increased NH_3-volatilization gradually up to 20 days of incubation and decreased after that. Similar results were observed by (Braithwaite et al., 1992). Results also revealed that application of metal salt urea with MCP reduced the volatilization of NH_3 particularly at the beginning of the incubation period. This phenomenon may explained by the acidity created from metal complexing of urea reduced NH_3-volatilization from hydrolyzed urea in soils, and additional acidity produced from hydrolysis of MCP. H_2O also can reduced NH_3 losses when materials were applied as multicomponent granules (metal salt urea + MCP).





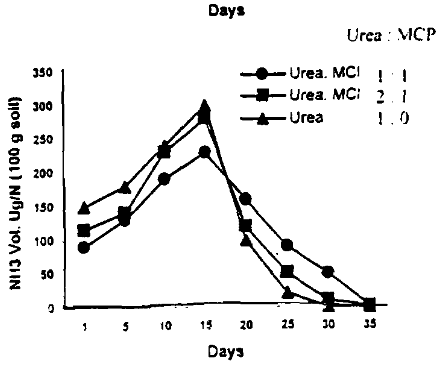
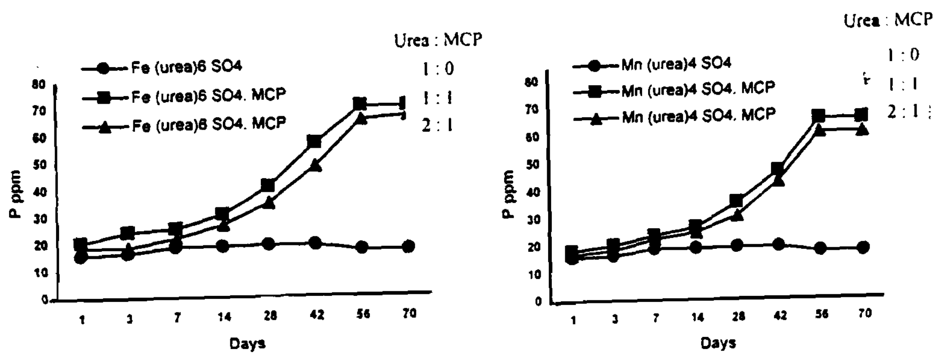


Fig. (6) : Effect of compacted metal salt urea with MCP on the NH3-volatilization during the incubation periods.

At the beginning of experiment when the metal salt urea was compacted with MCP the loss of NH_3 were 27 and 34% at ratios of 1 : 1 and 2 : 1 as compared with urea alone. Similar results were also observed when $Fe(urea)_6SO_4$ with or without MCP were used. Results also noticed that after 25 days of incubation amounts of NH_3-N losses from the applied urea-N, Mn $(urea)_4$ SO_4 and Fe $(urea)_6$ SO_4 were about 96%, 80% and 68% respectively. Similar results were observed by Fan et al. (1996) they reported that the addition of triple superphosphate and monoammonium phosphate compacted with urea reduced the rates of NH_3 loss and delayed the time of maximum NH_3 loss, the losses of NH_3 volatilization were 3.4 and 8.3% of applied N respectively. They also reported that such losses depending on the rate and source of phosphate applied.

Available-P :

Values of phosphorus released in soil treated with compacted metal salt urea with MCP are illustrated in Fig. (7). It was observed that the addition of metal salt urea without MCP gave a constant release of phosphours to the soil through the incubation period. The release of phosphorus from different products depending on some physical, chemical characteristics of the materials. The reaction with MCP to form the adduct complexing metal salts with MCP increase of these variation in the releaseable-P in the soil. It was observed that the addition of compacted metal salt urea with MCP at any ratio improved the characterization of metal salt urea complexes comparing with other treatments without MCP.



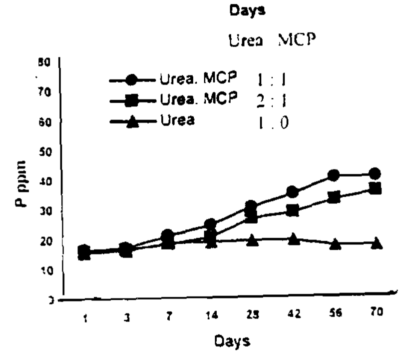


Fig. (7) : Effect of compacted metal salt urea with MCP during the incubation periods on available of phosphours (ppm)

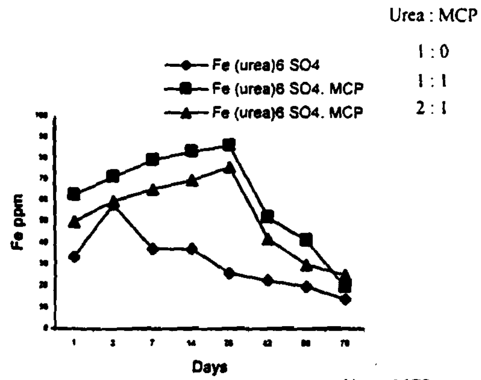
It was noticed that the addition of Fe $(urea)_6 SO_4$. MCP was more pronounced effect on the release of phosphorus than $Mn(urea)_4SO_4$.MCP. The availability of phosphorus with complexes metal salt urea with MCP at ratio of (1 : 1) were remarkable higher than the addition at a ratio of (2 : 1). This results can be explained by the fact that compaction brings the MCP and urea into proximity and thus enhances the interaction between urea hydrolysis and MCP dissolution in the soil as proposed by (Lupin and Le, 1983 and Officer, 1989).

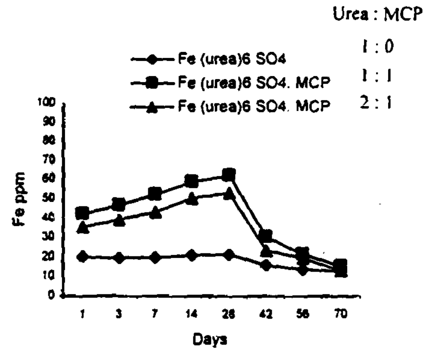
Results also showed that the addition of compacted urea. MCP gave the lowest value of available phosphorus in soils as compared with other treatments. The addition of urea. MCP at ratio of (1 : 1) was more effective on the release of phosphorus through the incubation period than the addition of urea. MCP at ratio of (2 : 1). Hedley et al. (1989) reported that the use of ammonium salts and urea in MCP granulation increases the solubility of phosphate rock by the action of acid generated through the nitrification process of the ammonium ions.

The extractable fractions of Fe and Mn :

The extractable fraction of Fe and Mn are plotted versus time for different ratios of compacted metal salt urea with MCP Fig. (8 & 9). It was observed that the addition of $Fe(urea)_6SO_4$ and $Mn(urea)_4SO_4$ without MCP gave the lowest value of Fe and Mn as compared with other treatments compacted with MCP. The availability of Fe and Mn with metal salt urea.MCP added were remarkable higher than urea MCP added. Increasing fractions of both Fe and Mn in compacted metal salt urea.MCP could be attributed to increasing the solubility product of studied element due to the action of acid generated through nitrification of the ammonium ions as reported by (Hedley et al., 1989). Application of Fe and Mn to complexes urea. MCP at any ratios increased the availability of iron and manganese in soil during the incubation periods. Available fractions of Fe and Mn increased with increasing the incubation period, and slightly declined probably due to completion of conversion processes of higher oxides of Fe and Mn forms as reported by (Borges-Perez et al., 1994).

Results also showed that the availability fraction of Fe and Mn in the treated soil with $Fe(urea)_6SO_4$.MCP or $Mn(urea)_4SO_4$.MCP, tended to increase as compared with compacted urea with MCP. This result may be due to the associations of Fe and Mn with urea and MCP through the formation of very stable complexes (Tsuksuki and Kuwatsuka, 1992) and probably due to the formation of stable complexes with Fe and Mn. These process may create suitable condition to maintain both fractions in available forms through increasing its solubility products (Bolan et al., 1993).





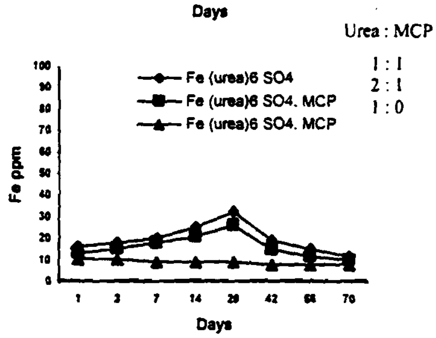
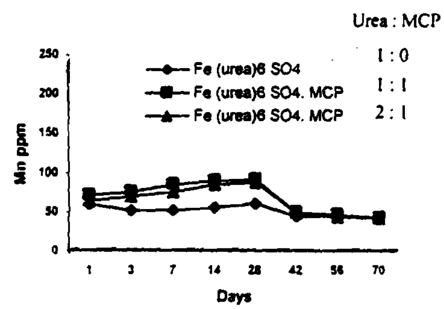
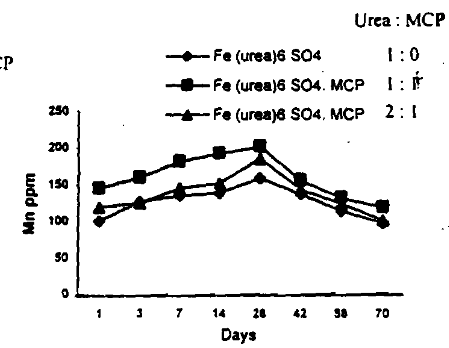


Fig. (8) : Effect of compact metal salt urea with MCP during the incubation period on the extractable fraction of iron (ppm).





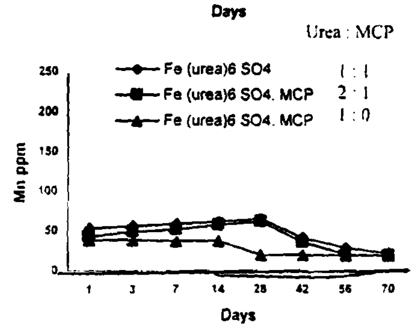


Fig. (9) : Effect of compacted metal salt urea with MCP during the incubation periods on the extractable fraction of manganese (ppm).

Biological experiment :

a. Plant growth :

The application of compacted metal salt urea with different ratios of MCP on the fresh and dry weight of radish plants are presented in table (2). Addition of compacted metal salt urea with MCP had significantly increased on the fresh and dry weight of radish plants at different stages of the growth. This probably due to the more intimate contact between the two fextilizers were applied to the soil (Hagin and Harrison, 1993). With the addition of Fe $(urea)_6$ SO_4 or $Mn(urea)_4$ SO_4 without compacted MCP the fresh and dry weight of shoot and root of radish plant was significantly increased as compared with compacted urea MCP. However the addition of compacted urea with MCP was a remarkable effect on root and shoot of radish plant as compared with urea alone. This result may be due to the fertilizer values of the materials that increased the availability of phosphorous and nitrogen to the radish plant as reported by (Mendoza, 1992).

It is more likely that the better performance of metal salt urea with compacted MCP than urea.MCP for increasing fresh and dry weight of shoot and root particularly at 30 and 90 days of plantations.

The release of the elements in compacted complexing urea.MCP can be regulated by altering the size and increasing the weight of root and shoot of radish plant. Similar trend was observed by Aasamae et al. (1993) they reported that the addition of micronutrients to complexing urea with MCP appeared to be useful for improving the flowability of the mixture and increasing the availability of some nutrients to the plants.

Table (2) : Effect of compacted metal salt urea with MCP on the fresh and dry weight of radish plant at different stages of growth (gm/plant) :

N-source	Urea : MCP	Fresh weight (gm/plant)				Dry weight (gm/plant)			
		Root		Shoot		Root		Shoot	
		30	90	30	90	30	90	30	90
Fe $(urea)_6$ SO_4	1 : 0	48.25	97.42	53.79	156.12	7.4	8.0	9.27	15.73
Fe $(urea)_6$ SO_4. MCP	1 : 1	69.05	127.04	110.54	195.15	8.58	12.85	13.86	19.1
Fe $(urea)_6$ SO_4. MCP	2 : 1	63.92	116.73	79.23	168.16	8.30	9.47	11.26	16.68
Mn $(urea)_4$ SO_4	1 : 0	48.05	81.79	45.88	147.50	7.08	7.65	8.22	14.85
Mn $(urea)_4$ SO_4. MCP	1 : 1	65.95	125.54	102.54	173.59	8.32	10.83	13.73	16.84
Mn $(urea)_4$ SO_4. MCP	2 : 1	63.88	105.48	71.39	164.78	7.72	8.84	10.72	15.8
Urea. MCP	1 : 1	43.47	69.52	43.68	105.62	6.53	7.35	7.6	14.5
Urea. MCP	2 : 1	40.33	58.99	43.60	90.69	6.46	6.96	6.52	14.0
Urea	1 : 0	36.24	44.77	40.56	58.64	6.32	6.52	6.23	13.0
L.S.D. 5%		3.13	7.27	6.13	15.03	0.26	1.42	1.03	1.25

Results also showed that the addition of compacted $Fe(urea)_6SO_4$.MCP or $Mn(urea)_4SO_4$.MCP at a ratio of (1 : 7) were more pronounced effect on shoot and root of radish plant at 30 and 90 days as compared with complexing urea with MCP at a ratio of (2 : 1). Results also showed that the rate of increase in fresh weight of shoot and root for compacted $Fe(urea)_6SO_4$.MCP and urea MCP at a ratio of (1 : 1) was reached to 37.04, 45.27 and 60.48, 45.8% at 30 and 90 days of plantation.

b. Plant composition :

Data in table (3 & 4) showed urea addition gave the lowest value of N-uptake as compared with other treatments. However compacted urea.MCP at any ratio was a remarkable effect on N-uptake for both shoot and root at different stages of the growth. It was noticed that the addition of $Fe(urea)_6SO_4$ and $Mn(urea)_4SO_4$ enhanced the utilized of N-uptake through improving the nutrient supply. Whereas the application of compacted Fe $(urea)_6$ SO_4 and/or Mn $(urea)_4$ SO_4 with MCP were more pronounced effect on the N-uptake of shoot and root at different stages of plant growth. This result may be due to the effectiveness of MCP for reducing NH_3 volatilizations from urea (Fan et al., 1996).

Results also revealed that the addition of $Fe(urea)_6SO_4$ and/or $Mn(urea)_4SO_4$ compacted with MCP increased the P-uptake at 30 and 90 days of planting. Such result could be explained by the beneficial effect of the material used and increases the solubility of MCP by the action of acid generated through nitrification of the ammonium ions (Hedley et al., 1989).

It was noticed that compacted urea.MCP at a ratio of (2 : 1) stimulate the P-uptake by plant. Data also showed that the addition of $Fe(urea)_6SO_4$.MCP or $Mn(urea)_4SO_4$.MCP at a ratio of (2 : 1) were more remarkable effect on P-uptake by plant. Metal salt urea compacted with MCP at a ratio of (1 : 1) was more pronounced effect on P-uptake by plant. Metal salt urea compacted with MCP at a ratio of (1 : 1) was more pronounced effect on P-uptake as compared with other treatments. This result can be explained by the fact that compaction brings the MCP and urea into proximity and thus enhances the interaction between urea hydrolysis and MCP dissolution in the soil as reported by (Lai and Eberl, 1986).

Results also revealed that application of metal salt urea compacted with MCP resulted in an increased the amounts of K in the radish plant. However application of urea granule or compacted with MCP the uptake of K decreased. This phenomena may be explained either by the development of the root system cause a considerable amount of the studied element (K) to be taken by the growing plant or may be the antagonistic effect between K and NH_4 (Jayarm and Alen, 1994 and El-Aila, 1998).

It was observed that the addition of $Fe(urea)_6SO_4$.MCP and $Mn(urea)_4SO_4$.MCP as (1 : 1) gave the highest value of K-uptake of plant (shoot and root) at 30 and 90 days of plantation as compared with other treatments. This could be explained either by the regulation of nitrogen release from compacted urea complexes which play an important role in ensuring efficient utilization of K, and the N-K interaction, or the integrated management of the N and K (El-Aila, 1998).

Data also showed that the addition of compated metal complexes urea with MCP improved the efficiency of Fe and Mn uptake of plant shoot and root especially as ratio of (1 : 1) than other treatments. Aasamae (1993) indicated that the addition of micronutrients to complexing urea appeared to be useful for increasing the solubility of Fe and Mn around the root and hence the uptake of their elements by plant increased (Bolan et al., 1993).

Table (3) : Effect of compacted metal salt urea with MCP on N, P, K, Fe and Mn-uptake by root of radish plant (mg/root):

N-source	Urea : MCP	30 days					90 days				
		N	P	K	Fe	Mn	N	P	K	Fe	Mn
Fe $(urea)_6$ SO_4	1 : 0	170.2	17.0	347.8	13.3	3.7	98.4	21.6	488.0	54.4	4.6
Fe $(urea)_6$ SO_4. MCP	1 : 1	272.8	29.2	493.3	18.8	4.2	242.8	75.8	1143.6	104.0	7.3
Fe $(urea)_6$ SO_4. MCP	2 : 1	200.0	23.2	423.3	15.7	4.2	125.9	26.5	634.4	76.7	5.8
Mn $(urea)_4$ SO_4	1 : 0	136.6	16.2	304.4	9.9	3.7	91.0	19.8	466.6	33.6	6.9
Mn $(urea)_4$ SO_4. MCP	1 : 1	205.5	23.2	449.2	14.9	4.4	144.0	35.7	763.5	64.9	7.3
Mn $(urea)_4$ SO_4. MCP	2 : 1	179.8	18.5	370.5	13.1	4.1	108.7	24.7	592.2	48.6	6.7
Urea. MCP	1 : 1	124.1	13.0	235.0	9.1	2.8	87.4	13.2	330.7	19.8	3.3
Urea. MCP	2 : 1	111.1	12.2	239.0	7.1	2.1	67.5	11.1	285.3	16.0	2.5
Urea	1 : 0	94.3	6.3	214.8	6.3	1.7	52.8	7.1	234.7	7.1	1.3

Table (4) : Effect of compacted metal salt urea with MCP on N, P, K, Fe and Mn-uptake by shoot of radish plant (mg/shoot):

N-source	Urea : MCP	30 days					90 days				
		N	P	K	Fe	Mn	N	P	K	Fe	Mn
Fe $(urea)_6$ SO_4	1 : 0	301.2	27.3	310.5	32.4	4.6	352.3	53.4	633.9	66.0	3.7
Fe $(urea)_6$ SO_4. MCP	1 : 1	546.0	52.6	602.9	58.2	7.3	754.4	93.5	1048.2	87.8	5.1
Fe $(urea)_6$ SO_4. MCP	2 : 1	370.4	40.3	410.9	41.6	5.6	408.6	65.0	700.2	73.3	4.1
Mn $(urea)_4$ SO_4	1 : 0	238.3	23.0	275.3	25.4	3.9	319.2	49.0	486.5	53.4	4.0
Mn $(urea)_4$ SO_4. MCP	1 : 1	466.8	50.8	562.9	46.0	8.6	410.3	72.4	724.1	65.6	4.8
Mn $(urea)_4$ SO_4. MCP	2 : 1	348.4	37.5	375.2	34.3	6.7	357.0	60.0	647.8	61.6	4.4
Urea. MCP	1 : 1	209.0	18.2	209.0	21.2	3.3	300.1	44.9	471.2	50.7	3.4
Urea. MCP	2 : 1	177.9	11.7	172.7	15.8	2.5	238.0	39.2	385.0	49.0	2.8
Urea	1 : 0	164.4	9.9	152.6	14.3	1.3	182.0	27.3	253.5	32.5	2.4

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اندماج سماد اليوريا المركب مع سماد السوبر فوسفات وتأثير ذلــك علــى نبــات الفجل

هشام إبراهيم العيلة
قسم تغذية النبات – المركز القومى للبحوث – الدقى – جيزة

أقيمت عدة تجارب معملية وزراعية بهدف تقييم سماد اليوريا المركب مع سماد ســوبر فوســفات الكالسيوم وذلك بهدف المحافظة على الخواص الطبيعية للسماد من حيث ظاهرة التعجن وذلك أثنـــاء عمليــة التخزين حيث أظهرت النتائج ما يلى :

- انخفاض ماء التأدرت (نسبة الرطوبة) عند انضغاط سماد معقد اليوريا المركب مع سماد سوبر فوسـفات الكالسيوم، كما لوحظ أن هناك زيادة فى نسبة الرطوبة عند كبس سماد اليوريا المحبب مع سماد ســوبر فوسفات الكالسيوم خلال فترة التخزين ·
- أدت زيادة النسبة بين سماد اليوريا وسماد السوبر فوسفات إلى زيادة رقم الحموضـــة والقلويــة (pH) بالتربة وذلك عند مقارنتها بسماد اليوريا المركب مع سماد السوبر فوسفات خلال فترة التحضين ·
- أشارت النتائج إلى أن إضافة سماد اليوريا منفرداً أدت إلى حدوث زيادة فى درجة التوصيل الكــهربائى للتربة والمعبر عنها (E.C)· بينما أدى انضغاط سماد اليوريا المركب مع السوبر فوسفات إلى حـدوث زيادة طفيفة فى درجة التوصيل الكهربى للتربة خلال فترة التحضين ·
- أظهرت النتائج أن كبس سماد معقد اليوريا المركب مع سماد السوبر فوسفات أدى إلى انخفاض كل مــن معدل تحلل اليوريا ومحتوى النيتروجين الغير عضوى (NH_4+NO_3)-N ومعدل التطـــاير للأمونيــا NH_3-volatilization مقارنة باليوريا المحببة المنضغطة مع السوبر فوسفات خلال فترة التحضين ·
- وجد أن هناك اختلافا كبيراً فى معدل انطلاق الفوسفور بالتربة من المركبات المختلفة نتيجة لاختـــلاف الخواص الطبيعية والكيميائية للمركبات المختلفة· كما أدى كبس سماد معقد اليوريا المركب مع ســـماد السوبر فوسفات عند أى نسبة إلى تحسين صفات السماد مقارنة بباقى المعاملات خلال فترة التحضين ·
- أدت إضافة سماد اليوريا المركب مع السوبر فوسفات إلى زيادة تيسر كل من عنصر الحديد والمنجنـــيز بالتربة خلال فترة التحضين ·
- كما أدت إنضغاط كل من سماد اليوريا المركب مع سماد السوبر فوسفات إلى زيادة فى كل من الـــوزن الطازج والجاف للأوراق والجذور لنبات الفجل، ومحتوى كل من النيتروجين والفوسفور والبوتاســـيوم والحديد والمنجنيز فى الأوراق والجذور لنبات الفجل مقارنة بإضافة سماد اليوريـــا المحبـــب + ســـماد السوبر فوسفات منضغطتين معاً ·

وعلى ذلك فإنه يمكن القول بأن كبس سماد معقد اليوريا المركب مع سماد السوبر فوسفات على هيئة أقراص أدى إلى زيادة كفاءة سماد اليوريا والسوبر فوسفات من خلال تحسين الخواص الطبيعية والكيميائية للمنتج النهائى وتحسين عمليات الإنبات للبذور وإمداد التربة بالعناصر المغذية الكبرى الصغرى ·