J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol 11 (12):757 - 764, 2020

Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Reducing Nitrate Leaching through the Soil Profile using some Nano-Sized Organic Residues

Cross Mark

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ABSTRACT

Two experiments were conducted; the first one, columns on loamy and sandy soils and the second one, pots on loamy soil only for radish plants (*Raphanus sativus* L) to study application of nanotechnology in agricultural purposes as reducing nitrate leaching and rationalizing urea fertilizer use. The urea granules coated with 2% pomegranate peels and tea spoil powder in bulk and nanosize. Six treatments were used as follow: control (without urea U0),normal urea (U), urea coated with pomegranate peels at bulk powder (PbCU), urea coated with pomegranate peels nanopowder (PnCU), urea coated with tea spoil at bulk powder (TbCU), urea coated with tea spoil nanopowder (TnCU). The leachate was collected every 3 days up to 21 days. The results showed that a significant variation in the nitrate leaching rate at two organic residues and two sizes were applied. The highest rate of nitrate leaching obtained after three days of incubation periods for all treatments compared to other periods. The results obtained showed that U treatment had the highest rate of nitrate leaching, while PnCU treatment was the lowest rate of nitrate leaching. PnCU treatment used as best result obtained from columns experiment in pots experiment on radish plants at rates of 100 (control), 75, 50, 25 and 10% of recommended dose. The results obtained from the pots experiment showed that PnCU treatment at rate 25% urea fertilizer of recommended dose improved yield and quality of radish plants grown in loamy soil due to slow nitrogen release and reduced loss of nitrates.

***Keywords*:**organic residues nanopowders , coated urea, nitrates leaching, loamy soil , radish yield productivity and rationalization urea fertilizer

INTRODUCTION

Urea fertilizer is the dominant inorganic nitrogen source used in the agricultural system (Harrison and Webb, 2001) and this leads to environmental damage due to loss of nitrogen by emission in the form of nitrous oxides (N2O-N) (Meijide et al., 2009) or volatilization in the form of ammonia gas (NH3-N) to the atmosphere (Turner et al., 2010) or leaching in the form of nitrates (NO3-N) to the groundwater level (Menendez et al., 2009).

Nitrification is considered undesirable due to the NO3-N leaching, as it causes various diseases and greenhouse gases emissions (Maqsood, 2016). 70% of the applied N fertilizer is lost via nitrification and other N transformations (Giles, 2005).

Urea hydrolysis in soil into NH3 and NH4+ can be nitrified to NO3− by microflora. Most plant species prefer NO3− but a few plant species prefer NH4+. NO3− an anion and does not bind easily to a negative charged of soil and colloids and thus, NO3− is highly mobile in soil. To reduce NO3−mobility, coated N fertilizers may be a better approach (Trenkel, 2010).

Although, the NH4-N adsorbed on the clay particles is not vulnerable to losses but the concentration of NH4-N in soil is generally low i.e. 1 mg Kg-1, due to its immediate conversion to NO3-N (Subbarao et al., 2006). Rate of nitrification depends upon the soil properties such as temperature, pH, organic matter, moisture, aeration and availability of NH4-N present.

Inhibitors of nitrification and N slow-release urea are improving urea N use efficiency and decreasing loss of nitrogen in all its forms (Sanz-Cobena et al., 2012). These fertilizers can be released in accordance with the demand of the plant and thus supply enough nitrogen throughout the growing season and reduce the nitrogen accumulation in fruits and vegetables at the form of nitrates (Sabahi et al., 2017).

Many nitrification inhibitors such as p-benzoquinone and hydroquinone, nitrapyrin, DMPP (3,4dimethylepyrazole phosphate), DCD(dicyandiamide), and NBPT[N-(*n*-butyl) thiophosphorictriamide] (Sanz-Cobena et al., 2012) and slow-release urea forms, such as coated, chemically and bio-chemically modified, and granulated forms (Hutchinson et al., 2003) have been developed and applied to a number of different plant species growing in a range of varied environments. Many of these chemicals have been restricted to experimental uses because of their high cost, limited availability, and adverse influence on beneficial soil microflora (Sabahi et al., 2017).

Use a natural products of nitrification inhibitors such as Menthaspicata oil (Patra et al., 2009), neem oil (Majumdar et al., 2000), Artemisia annua powder (Mohanty et al., 2008) and karanjinfurano-flavonoid obtained from Pongamiaglabra (Majumdar, 2002) can be effective but high cost.

Nitrification inhibitors also can be used from plant residues containing polyphenols, lignin, cellulose and hemicellulose (Quideau et al., 2011). These wastes can be

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DOI: 10.21608/jssae.2020.160913

inhibit / re-mineralize inorganic fertilizers such as urea (Sabahi et al., 2014) in addition, plant wastes containing polyphenols and lignin can be growth stimulants, crop genome modifiers, control the grouping and form of nutrients available (phosphorus and microelements) to plants and/or microbes (Hattenschwiler and Vitousek, 2000 and Popa et al., 2008), and thus are an inhibit nitrification and low cost. Natural nitrification inhibitors include pomegranate peels (Punica granatum L.) and tea spoil (Camellia sinensis, Theaceae), which contain a considerable shares of polyphenols (Mirdehghan and Rahemi, 2007 and Yang et al., 2008).

The antioxidant activity of pomegranate and tea depended on the concentration of phenolic compounds (Naveena et al., 2008 and Yang et al., 2008), the pomegranate and tea have antimicrobial properties (Romeo et al., 2015 and Bansal et al., 2013).

Pomegranate and tea polyphenols are known to be strong antioxidants (Naveena et al., 2008 and Yang et al., 2008), too, the polyphenols could generate reactive oxygen species that stimulate up regulation of the endogenous antioxidant systems, and have been shown to react with reactive oxygen species, such as hydroxyl radical, nitric oxide, nitrogen dioxide (Yang et al., 2008).

Coating of urea granules by nanopowder of both pomegranate peel and tea spoil increases the nitrification inhibition effectiveness. Nanomaterials are commonly referred to as small objects with one or more external dimensions in the size range 1–100 nm. At these dimensions, materials exhibit a distinctive behavior in comparison to larger particles of the same composition (Zuverza-Mena et al., 2016).

Radish is one of the most ancient cultivated plants, and it is a common food in Egypt. Radish is also the popular crop of the biovegetable producers in the whole world (Gruver et al., 2016). Radish vary in color from white to black and usually harvested two or more terms.

The aim of the research is to apply nanotechnology for agricultural purposes, reducing groundwater pollution with nitrates, improving and rationalizing the use of nitrogenous urea fertilizers.

MATERIALS AND METHODS

The organic plant residues (pomegranate peel and tea spoil) were dried in the shade for 4 –7 days. Dried organic plant wastes were ground by a kitchen mill for production a fine powder. The powder was passed throughout a sieve 0.25 mm, then, the passing powder was taken to re-grind it to obtain a nanopowder. Fig. (1) revealed that the characterization of pomegranate peel and tea spoil powder for its morphology and size by transmission electron microscopy (TEM) HRTEM, JEOL 3010).

Urea fertilizer (46.5%) coated with arabic gum as a fixative material then, urea granules was coated with pomegranate peel and tea spoil powder both as nanopowder. Then, uncoated and coated urea granules were used in the experiment with six treatments. The treatments were, control (no urea U0), normal urea (U), pomegranate peel bulk powder coated urea (PbCU), pomegranate peel nanopowder coated urea (PnCU), tea spoil bulk powder coated urea (TbCU) and tea spoil nanopowder coated urea (TnCU).

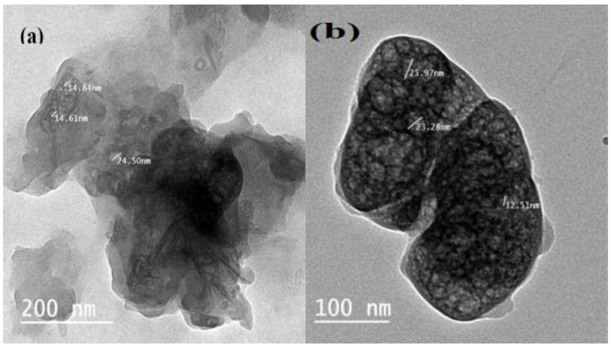

Fig. 1. TEM images of (a) pomegranate peel and tea spoil (b) nanopowders.

1.34 gm (equivalent to 6231 mg Nkg-1) uncoated and coated urea granules were applied on top surface of the soil column with different sources in respective treatments except control, with three replicates maintained under each treatment. About 500 ml distilled water was added directly after fertilizer application, then every 3 days until the end of the experiment. The leachates collected in plastic jars (about 300 ml) were removed to estimate nitrates at each time (0, 3, 6, 9, 12, 15, 18 and 21 days) to follow up the effect of pomegranate peel and tea spoil at different sizes on nitrate leaching throughout the soil columns.

Two types of soil (loamy and sandy soils) with 36 columns (18 columns for each soil), the soil columns weight was one kilogram, and the column was immersed in distilled water for 24 h to saturate the entire soil column (5 cm diameter, 40 cm length and 30cm soil column).

The collected soils samples were mixed, homogenized, sieved (< 0.25 mm) for packing plastic columns and determine organic matter according to Piper (1950). Soil pH (using pH meter model WTW Series pH 720) was determined in 1:2.5 soil water suspensions according to the standard method described by Richards (1954). Total soluble salt (using EC meter model WTW Series Cond 720) were measured in soil paste extract as method described by Jackson et al., (1973). Total CaCO3 content and soluble cations and anions were carried out according to Jackson et al., (1973). Nitrogen as NO3-N was determined by ultraviolet spectrophotometer (model JENWAY 6705 UV/Vis) according to Armstrong (1963). Phosphorus was determined colorimetrically according to method described by (AOAC, 2012) using spectrophotometer (model JENWAY 6705 UV/Vis) and potassium was determined using Flame-photometer (model JENWAYPFP7), according to Jackson et al., (1973). Available micronutrients were extracted by DTPA according to Lindsay and Norvell (1978) and determined using Atomic Absorption Spectrophotometer (model, analyticjenanovAA 350). Data obtained tabulated in Table (1) and (2) and showed some physical and chemical characteristics of the loamy and sandy soils under study.

A pot experiment was conducted in the Agricultural Research Center. Urea coated by 2% pomegranate peels nanopowder was chosen as a best treatment to reduce nitrate leaching throughout the soil columns. The soil was put into pots with a 2 kg capacity from both of calcareous loamy soils, and five seeds of radish (Raphanus sativus L) at pot were planted on October 4, 2019., Five treatments of coated urea with 2% pomegranate peel nanopowder applied to soils at rates of 10, 25, 50, 75 and 100% (control) which equal to 9, 22.5, 45, 67.5 and 90 kg N/fed urea fertilizer were distributed in the soil surface layer of pot with three replicates for each rate arranged as complete at randomize block design.

Table 1. Some physical and chemical characteristics of the loamy soil

Soil characteristics			Value	Soil characteristics		Value
Particle size distribution %:				**Soluble cations (mmol$_c$l^{-1})**		
Sand			51.07	Ca^{2+}		6.58
Silt			27.80	Mg^{2+}		2.12
Clay			21.10	Na^{+}		5.30
Textural class*			Loamy	K^{+}		0.37
Soil chemical properties:				Soluble anions (mmol$_c$l^{-1})		
pH (1:2.5 soil water suspension)			8.10	CO_3^{2-}		0.00
ECe (dS/m, soil paste extract)			1.44	HCO_3^{-}		1.89
$CaCO_3$ %			29.6	Cl^{-}		4.24
Organic matter %			1.55	SO_4^{2-}		8.25
Available macro and micronutrients (mg kg^{-1})						
N	P	K	Fe	Mn	Zn	Cu
75.19	31.91	3900	0.56	0.32	0.38	0.22

***International texture triangle**

Table 2. Some physical and chemical characteristics of the sandy soils

Soil characteristics			Value	Soil characteristics		Value
Particle size distribution%:				**Soluble cations (mmol$_c$l^{-1})**		
Sand			97.53	Ca^{2+}		2.63
Silt			0.98	Mg^{2+}		2.80
Clay			1.49	Na^{+}		2.23
Textural class*			Sandy	K^{+}		0.74
Soil chemical properties:				Soluble anions (mmol$_c$l^{-1})		
pH (1:2.5 soil water suspension)			7.70	CO_3^{2-}		0.00
ECe (dS/m, soil paste extract)			0.84	HCO_3^{-}		2.83
$CaCO_3$ %			2.70	Cl^{-}		4.24
Organic matter %			0.50	SO_4^{2-}		1.34
Available macro and micronutrients (mg kg^{-1})						
N	P	K	Fe	Mn	Zn	Cu
14.63	2.36	962	0.39	0.25	0.23	0.12

***International texture triangle**

Plant samples were collected from each pot to determine some plant growth at maturity stage, some pigments, nutritional status and yield productivity. Plant samples were oven dried at 70 °C, then fine grinded. Plant samples were digested using H_2SO_4+ $HClO_4$ (1:1v/v) acid mixture to determine macro (N, P and K) and micronutrients, using flam photometer and atomic spectrophotometer, respectively, according to A.O.A.C. (2012). Photosynthetic pigment content as total chlorophyll and carotenoids content were determined in fresh leaves according to Sumanta *et al.* (2014).

The data were statistically analyzed using one-way analysis of variance test by the least significant difference (LSD at 0.05) according to method described by Gomez and Gomez (1984) using IBM SPSS Statistics 20 program.

RESULTS AND DISCUSSION

Columns experiment

Effect of organic residues on nitrate leaching throughout the soil columns.

The amount of NO_3-N was leached from the calcareous loamy soil treated by urea uncoated (U) and coated with organic plant residues at different sizes and time intervals has been revealed in Table (3).

Data showed that, application of uncoated and coated urea (1.34 gm kg^{-1}soil column^{-1}which equal 6231 mg N kg^{-1}) by different organic plant residues sizes led to a significant variance of NO_3-N leaching from the soil columns. The content of NO_3-N was leached from soil columns during the experiment was very low after distilled water addition directly (0 time). Moreover, the nitrate leaching was high in the primary stages of the experiment after application of urea uncoated and coated by organic residues at different sizes (Jadon *et al.*, 2018). The highest nitrate leaching rate was observed after 3 days incubation period, with values 2357.09, 1865.53, 1496.18, 1146.75, 708.87and 15.31 mg N kg^{-1} soil for U, TbCU, PbCU, TnCU, PnCU and U0, respectively.

Table 3. Effect of organic residues on nitrate leaching loss (mg N kg^{-1} soil) throughout the loamy soil columns.

Time /	Treatments of urea used at different coating organic residues							
days	U0	U	PbCU	PnCU	TbCU	TnCU	Mean	LSD
0	14.45	27.18*	33.38*	1.36*	8.28	6.10	15.13	11.37
3	15.31*	2357.09*	1496.18*	708.87*	1865.53*	1146.75*	1337.46	398.79
6	29.54*	1048.53*	886.84	401.63	986.78*	447.81*	683.52	193.76
9	29.76*	788.37*	533.59	304.58	648.32	333.98	439.77	31.51
12	10.00	391.53*	484.36	617.61	443.13	502.93	408.26	31.51
15	11.26	240.19*	384.17	419.73	299.22	370.92	287.58	120.68
18	5.17	49.34*	89.8*	160.58	68.27	133.39	84.43	49.12
21	9.99	9.20*	22.73*	72.27	15.59	25.41	25.87	11.37
Mean	15.69	613.93	491.38	335.83	541.89	370.91	394.94	-----
Cumulative NO_3-N	125.48	4911.43	3931.05	2686.63	4335.12	2967.28	-----	-----
NO_3-N leached%	-----	76.81	61.08	41.10	67.56	45.61	-----	-----
NO_3-N reduced%	-----	23.19	38.92	58.90	32.44	54.39	-----	-----

***The mean difference is significant at the 0.05 level.**

However, the rates of nitrate leaching from uncoated and coated urea applied to soil columns at different sizes and time were varied as shown in (Fig.2). After 9 days incubation period, the rate of nitrate leaching decrease was highest value with U (788.37mg N kg^{-1} soil) applied soil in compare with other treatments used.

The results in Table (3) indicated that the PnCU treatment gave the highest nitrate loss rate after 12 days incubation period with value 617.61mg N kg^{-1}soil compared to the other treatments TnCU, PbCU, TbCU and U with values 502.93, 22.484.36, 443.13 and 391.53mg N kg^{-1}soil, respectively.

Also, the total amount of NO_3-N was leached from the soil columns treated with uncoated and coated urea U, TbCU, PbCU, TnCU, PnCU and (U0) were 4911.43, 4335.12, 3931.05,2967.29, 2686.63 and 125.48 mg N kg-

[1]soil, respectively. Data observed there was significant difference between coated and uncoated urea applied to soil in regard to total amount of NO_3-N leached during the experiment period (Jadon *et al.,* 2018). It means that may be nitrogen was released slowly in coated urea treatments due to the reduced nitrification rate (Kashiri and Kumar, 2016).

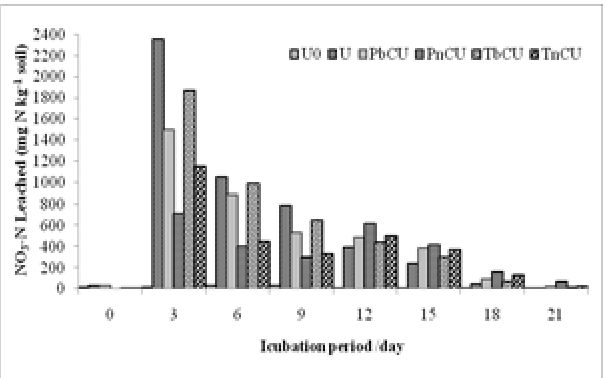

Fig. 2. Effect of pomegranate peel and tea spoil (bulk and nanopowder) on NO_3-N leaching during the loamy soil columns.

Moreover, there was a significant difference observed between applied soil with organic plant residues at bulk powder sizes (PbCU and TbCU) and organic plant residues at nanosizes (PnCU and TnCU) in total amount of nitrate leaching. Among the different sources of organic plant residues at different sizes applied, PnCU applied soil had the lowest total nitrate leaching and was significantly differ from other treatments. Fig 3, showed the percent loss of NO_3-N leaching from uncoated and coated urea for U, TbCU, PbCU, TnCU and PnCU and were 76.81, 67.56, 61.08, 45.61and 41.10%, respectively.

On the other hand, it could be reduce nitrate leaching by coating urea granules with pomegranate peels and tea spoils powder. The percentage reduction of nitrate loss varied between pomegranate peels powder (PbCU) and tea spoil powder (TbCU) as follows, 38.92 and 32.44%, respectively. The nanopowder of the pomegranate peels (PnCU) and tea spoil (TnCU) had another effect on reducing nitrate leaching, as follows: 58.90 and 54.39%, respectively, compare to normal urea with value 23.19%.

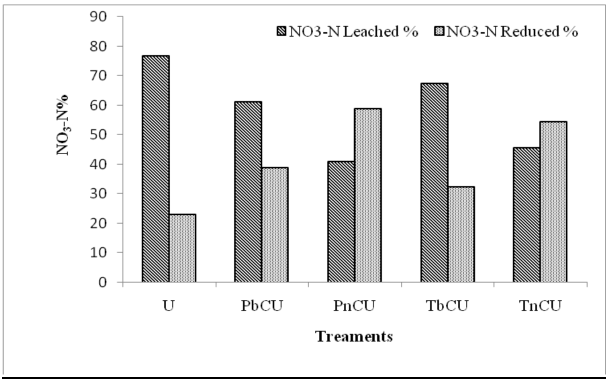

Fig. 3. Percentage of NO_3-N leached and reduced to urea fertilizer uncoated and coated by organic residues at different sizes in loamy soil.

The obtained results indicated that the urea granules coated by plant residues at different sizes reduced NO_3-N leaching through the soil columns with different rates (Patra *et al.,* 2009).

Sigurdarson, *et al.* (2018) noticed that at neutral or basic pH (pH >7), NH_3 will be formed and is lost through emission. At acidic pH (pH <7), most of the NH_3 will be converted to cationic ammonium that cannot evaporate. The direct effect related to the acidic pH of pomegranate peels powder (pH=3.75) as recorded by (Ullah *et al.,* 2012).So, coating urea with pomegranate peels powder could be led to reduce nitrogen losses at all forms by effect of pH number, nitrogen slow release and nanosized.

The total polyphenol content of pomegranate peels and tea spoil powder were 5.30 and 3.57%, respectively, this agreed with Mirdehghan and Rahemi (2007) and Yang *et al.,* (2008) and Pomegranate peels and tea spoil powder have the ability to reduce the hydrolysis of urea fertilizer in calcareous loamy soil. Plant polyphenol are one of the most known N inhibitors (Quideau *et al.,* 2011). It has also been supposing polyphenol can reduce nitrate leaching by immobilize/remineralize inorganic fertilizers such as urea (Sabahi *et al.,* 2015). N nitrification inhibitors have also been inserted as another way to improve fertilizer use efficiency at low cost (Behin and Sadeghi, 2016).

Data in Table (4) and Fig.(4) showed that the effect of organic plant residues coated urea at different sizes with interval times on amount of NO_3-N leaching throughout the sandy soil columns. The results indicated that the nitrate loss behavior in the sandy soil is the same as in loamy soils.

Table 4. Effect of pomegranate peel and tea spoil powder and nanopowder on nitrate leaching loss (mg N kg^{-1} soil) throughout the sandy soil column.

Time /	Treatments of urea used at different coating organic residues							
days	U0	U	PbCU	PnCU	TbCU	TnCU	Mean	LSD
0	1.90	2.64*	2.57	2.5	3.1	4.91	2.94	0.11
3	1.55*	303.38*	206.95*	176.23*	283.04*	189.62*	193.46	45.95
6	0.21	78.73*	33.45	6.05	36.99	10.22	27.61	24.67
9	2.08	23.55*	8.48	4.96	13.47	6.13	9.78	6.84
12	0.73	1.66*	3.20	6.29	2.79	4.33	2.83	0.11
15	0.63	0.98*	1.26	3.45	1.86	2.17	1.73	0.85
18	0.27	0.34*	0.69	0.95	0.64	0.81	0.62	0.26
21	0.10	0.60*	1.01	1.39	0.88	1.26	0.87	0.26
Mean	0.85	51.49	7.24	3.66	8.53	4.26	29.98	
Cumulative NO_3-N	7.47	411.88	257.61	201.82	342.77	219.45	---	---
NO_3-N leached %	---	6.49	4.01	3.12	5.38	3.40	---	---
NO_3-N reduced%	---	93.44	95.99	96.85	94.56	96.56	---	---

***The mean difference is significant (LSD) at the 0.05 level.**

The highest rate of nitrate leaching after 3 days was as follows: 303.38, 283.04, 206.95, 189.62, 176.23 and 1.55 mg N kg^{-1} soil for U, TbCU, PbCU, TnCU, PnCU and U0, respectively, and then gradually decreases until the end of the experiment after 21 days. The results also in Table (4) showed that the coating of urea with pomegranate peels nanopowder gave the highest value of nitrate leaching after 12 days as follows: 6.29, 4.33, 3.20, 2.79, 1.66 and 0.73 mg of NO_3^{-} kg^{-1} soil for U, TbCU, PbCU, TnCU, PnCU and U0, respectively. Therefore, the rate of nitrogen loss at the form of nitrates was lower in sandy soil, perhaps nitrogen loss in sandy soil maybe occurred in a form of ammonia gas by volatilization or emission of nitrogenous oxides. Ammonia volatilization loss is greater with urea or ammonium sulfate compared to that from ammonium nitrate or potassium nitrate (Liu *et al.*, 2007).

Urea hydrolysis lead to an increase in the amount of NH_4-Nand decrease in the amount of NO_3-N in sandy loam soil (Antil *et al.*, 1992). The total recapture of Urea-N + NH_4-N was high in sandy soil than in sandy loam soil may be more losses of N in the form of NH_3 or fixation of NH_4^+but the NO_3-N formation was not noticed in both soils (Singh *et al.*, 1984).

Further, study and research is required in order to use urea coating materials that are more effective in reducing nitrogen loss, whether by volatilization as ammonia or emission as nitrogen oxides in sandy soils.

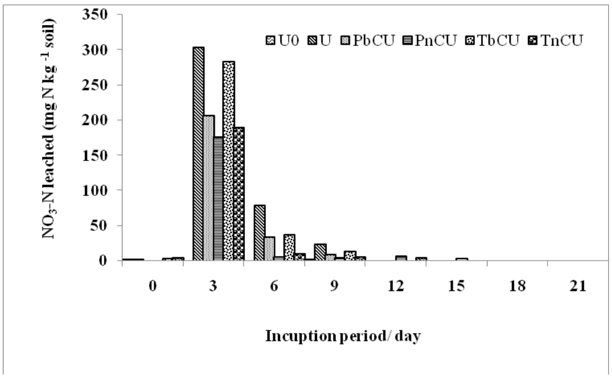

Fig. 4. Effect of pomegranate peel and tea spoil (bulk and nanopowder) on NO_3-N leaching during the sandy soil column.

From the above mention, data appeared that the coating of urea granules with 2% pomegranate peels nanopowder, gave a lowest rate of nitrate loss whether in loamy calcareous or sandy soils. Nutrients become available when the coating degrades to expose them or when nutrients diffuse through small pores in the coating, (Behin and Sadeghi, 2016). Moreover, pomegranate peels and tea spoil contain a considerable amount of polyphenolic compounds (antioxidant and antimicrobial) that inhibit or reduce the hydrolysis of urea (denitrification) and thus reducing urea loss in the form of nitrates, so pomegranate peels and tea spoil are considered nitrification inhibitors. Nitrification inhibition can improve N use efficiency and reduce NO_3^- leaching (Zerulla *et al.*, 2001).

Finally, from data obtained previously could be concluded that urea coated by 2% pomegranate peels nanopowder (PnCU) was chosen as a best treatment to reduce nitrate leaching throughout the soil columns.

So, PnCU treatment was used as applied with radish plants in the pots experiment to rationalize the use of urea fertilizer and test the efficiency of this treatment in quality and quantity yield of radish plant.

Pots experiment

Effect of 2% pomegranate peel nanopowder coated urea on some growth parameters of radish plant.

The results in Table (5) indicated that 2% pomegranate peel nanopowder coated urea granules at rates of 100 (control), 75, 50, 25 and 10% (from urea fertilizer recommended dose) were significant and positive effect on some growth parameters of radish plants grown in loamy soil. The values ranged from 29.04 to 32.05 cm, 5 leaves, 17.51 to 20.20 cm, 11.50 to 12.82 cm,1.23 to 1.86 cm, 28.42 to 30.70 g and 7.26 to 7.85 g compared control (100%) which was 33.00 cm, 6 leaves, 21.00 cm, 12.30 cm, 1.64 cm, 30.06 g and 7.68 g for each of plant length, number of leaves, leaf length, root length, root diameter, plant fresh weight and plant dry weight of radish plants were grown in calcareous loamy soil, respectively, the difference between values of all rates and control value (100% full recommended dose of nitrogen) was nearly small. There was no much significant difference observed between treatments.

Pomegranate peels increased biomass and yield by improving growth parameters of plants and controlling the release of available N by plant polyphenols (Haettenschweiler and Virtuosic, 2000 and Quideau *et al.*, 2011).

Table 5. Effect of pomegranate peel nanopowder coated urea on some growth parameters of radish plant.

Fertilizer rate (%)	Plant length (cm)	No. of leaves $plant^{-1}$	Leaf length (cm)	Root length (cm)	Root diameter (cm)	Fresh weight $plant^{-1}$(g)	Dry weight $plant^{-1}$ (g)
100	33.00	6.00	21.00	12.30	1.64	30.06	7.68
75	32.05	5.00	20.20	12.00	1.75	29.79	7.61
50	28.72	5.00	17.51	12.23	1.23	28.42	7.26
25	29.71	5.00	18.22	11.50	1.73	30.70	7.85
10	29.04	5.00	19.23	12.82	1.86	29.83	7.62
Mean	30.50	5.20	19.23	12.17	1.64	29.76	7.60
LSD at 0.05	2.37	0.56	1.76	0.60	0.30	0.39	0.27

***The mean difference is significant (LSD) at the 0.05 level.**

Effect of 2% pomegranate peels nanopowder coated urea on some pigments and yield of radish plant.

In Table (6) data showed that there was a positive effect to use 2% of pomegranate peel nanopowder coated urea at all rates applied. The differences were small between the values and control (100%) for both total chlorophyll and carotenoids, the values were ranged between 2.35 to 2.65 mgg^{-1} F.W. and 1.40 to 1.57 mgg^{-1} F.W., respectively, as well as the values of yield were close with control and it ranged between 8.55 - 9.22 ton fed^{-1}.

Urea granules coated with pomegranate peels can release their N in synchrony with plant demand (Sanz-Cobena *et al.*, 2012).

Table 6. Effect of pomegranate peel nanopowder coated urea on pigments and yield of radish plant.

Fertilizer rate (%)	Total chl. mgg^{-1} F.W.	Carotenoids mgg^{-1} F.W.	Total yield ton fed^{-1}
100	2.65	1.57	9.03
75	2.54	1.52	8.95
50	2.36	1.40	8.55
25	2.59	1.53	9.22
10	2.55	1.51	8.96
Mean	2.54	1.51	8.94
LSD at 0.05	0.14	0.08	0.30

In addition, could be possible to supply sufficient N to satisfy plant requirements and enhanced uptake other nutrients by reducing competition between nitrogen and other nutrients (*i.e*. enhanced phosphorus uptake through vegetative growth stages compare to nitrogen) while maintaining a sufficient concentration of mineral N in the soil during the growth season. (Sabahi *et al.*, 2017)

Effect of pomegranate peels nanopowder coated urea on macro and micro nutrients contents of radish plant.

Data in Table (7), showed that a positive effect to use coated urea by 2% pomegranate peels nanopowder with macro and micro nutrient contents in radish plants at all urea coated rates applied. As expected, all coated urea rates increased total macro and micro nutrient contents with varying values in the radish plants. Total macro and micro nutrient contents were significant as compared to control one (100% full recommended dose of nitrogen).

Table 7. Effect of pomegranate peel nanopowder coated urea on macro and micro nutrient contents of radish plant

Fertilizer rate (%)	N	K	P	Ca	Mg	S	Fe	Mn	Zn
	%				$mgkg^{-1}$				
100	2.51	3.36	2.07	0.40	0.24	1.92	198.20	16.88	51.09
75	2.80	3.82	2.66	0.60	0.48	1.72	221.10	19.11	37.07
50	2.53	2.98	1.85	0.75	0.30	1.86	296.56	14.80	40.33
25	3.43	3.74	2.48	2.00	1.50	1.50	271.75	11.86	59.48
10	3.08	3.40	2.96	1.20	0.36	2.74	275.40	15.43	48.39
Mean	2.87	3.46	2.40	0.99	0.58	1.95	252.60	15.62	47.27
LSD at 0.05	0.67	0.42	0.56	0.79	0.58	0.59	51.09	3.32	11.06

The highest value of macro nutrient contents in radish plants were 3.43%, 2.96 $mgkg^{-1}$, 3.74%, 2.00, 1.50 and 2.74 $mgkg^{-1}$ for each N, P, K, Ca, Mg and S at rate of applied nitrogen in 25, 10, 25, 25, 25 and 10%, respectively, while, the highest value were 296.56, 19.11 and 59.48 $mgkg^{-1}$ for Fe, Mn and Zn at rate of applied nitrogen in 50, 75 and 25%, respectively. As previously mentioned, controlling the release of available nitrogen improves the uptake of other nutrients for plant by reducing competition.

Data obtained is agreed with Sabahi *et al.*, (2017) who noticed that pomegranate peel in the 100% w/w equivalent to the applied urea compared to urea alone increased biomass and yield of plants significantly. On other hand, Kiran and Patra (2003) dictated that urea coated with the dried plant materials increased herb yield from 6-81% when compared to uncoated urea in a pots experiment. Also, pomegranate peels increased quality and quantity of yield by balanced of N and P availability and its uptake by plant. Northup *et al.* (1998) who assumed that pomegranate peels and what contains of polyphenols, cellulose and hemicellulose compounds can affect or control of the competitive advantage between the nutrients contents and its uptake by plant and becomes more effective when its grinding to nano size.

CONCLUSION

Could be concluded that coating urea granules with 2% pomegranate peels and tea spoil nanopowder caused of nitrogen slow release and reducing nitrates leaching, which led to reduce ground water pollution and rationalizing the use of urea fertilizer economically with low cost. Coating urea granules with 2% pomegranate peels nanopowder improving growth parameters, pigments, nutrimental status and yield quality and quantity for radish plants. Coating urea granules with 2% pomegranate peels nanopowder decreased urea fertilizer to 25% from recommended dose.

Finally, plant residues are considered environmental pollutants, and by using it can be reducing some environmental pollution and plant residues utilization can be maximized by applying nanotechnology.

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الحد من غسيل النترات خلال القطاع الارضى باستخدام بعض المخلفات العضوية بحجم النانو

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أجريت تجربتين الأولى تجربة أعمدة على تربة طميية (تربة جيرية) ورملية والثانية تجربة أصص علي تربة طميية فقط وذلك لدراسة تطبيق النانو تكنولوجي في الأغراض الزراعية بغرض تقليل فقد النتروجين في صورة نترات بالغسيل و ترشيد استخدام سماد اليوريا. و قد تم استخدام المخلفات العضوية في التغليف و ذلك باستخدامها بنوعين من حجم مسحوق الطحن إما الطحن أوفي الحجم النانوي وكان هذا علي نوعين من المخلفات العضوية (قشور الرمان وتفل الشاي). حيث تم تغليف حبيبات اليوريا بنسبة ٢٪ من مسحوق قشور الرمان وتفل الشاي بكل من نوعي حجم مسحوق الطحن حيث كانت المعاملات التي تم استخدامها في تجربة الأعمدة علي سماد اليوريا في صورتين إما غير المغلفة أوالمغلفة بستة معاملات في التجربة, وكانت المعاملات هي: المقارنة (بدون يوريا U0) ، اليوريا العادية (U) ، اليوريا المغلفة بمسحوق قشر الرمان بحجم الطحن المعتاد (PbCU) ، اليوريا المغلفة بمسحوق الرمان بحجم الطحن النانوى (PnCU) ، اليوريا المغلفة بمسحوق تفل الشاي بحجم الطحن المعتاد (TbCU) اليوريا المغلفة بمسحوق تفل الشاي بحجم الطحن النانوى (TnCU). تم تجميع الراشح كل ٣ أيام حتى ٢١ يومًا خلال مدة تجربة الأعمدة. و قد أظهرت النتائج التي تم الحصول عليها من تجربة الأعمدة أن استخدام اليوريا غير المغلفة والمغلفة بواسطة كل من مطحون قشور الرمان و تفل الشاي بالحجمين المستخدمين في التجربة أن هنالك تباين كبير في معدل غسيل النتروجين في صورة نترات. كما تم الحصول على أعلى معدل لغسيل النتروجين في صورة نترات كان بعد ثلاثة أيام من فترة التحضين لكل المعاملات مقارنة بالفترات الأخرى للتحضين تحت الدراسة. كما سجلت النتائج المتحصل عليها أن اليوريا الغير مغلفة كانت ذات اعلي معدل غسيل للنتروجين الموجود في التربة علي صورة نترات بينما كانت اليوريا المغلفة بنسبة ٢ % من مسحوق طحن قشور الرمان النانوى أقل معدل في غسيل النتروجين في صورة نترات عن باقي المعاملات تحت الدراسة. لذلك ، تم استخدام تطبيق اليوريا المغلفة بنسبة ٢ % من مسحوق طحن قشور الرمان بالحجم النانوى كأفضل نتيجة تم الحصول عليها من تجربة الأعمدة في تجربة الأصص على نباتات الفجل (*Raphanus sativus* L) علي التربة الطميية فقط و بمعدلات أضافة ١٠٠ (معاملة المقارنة) و ٧٥ و ٥٠ و ٢٥ و ١٠٪ من الجرعة الموصى بها. وقد أظهرت النتائج التي تم الحصول عليها من تجربة الأصص أن أضافة اليوريا المغلفة بنسبة ٢% من مسحوق قشور الرمان بالحجم النانوي للتربة الطميية المستخدمة في الدراسة بمعدل ٢٥٪ من الجرعة الموصى بها من سماد اليوريا إلى زيادة في محصول وجودة نباتات الفجل المزروعة وقد يكون ذلك بسبب بطء إنطلاق النيتروجين من سماد اليوريا المغلفه بالمسحوق النانوي والذي أدي إلي تقليل فقد النتروجين الموجود في صورة نترات. أخيرًا ، هذا قد يعني أن اليوريا المغلفة بنسبة ٢% من مسحوق طحن قشور الرمان بالحجم النانوى أقل فقدا للنتروجين الموجود في صورة نترات مقارنه في ذلك بالمعاملات الأخري المختلفة المضافة تحت الدراسة مما أدى إلى الحصول على محصول جيد من نباتات الفجل باستخدام أضافة ٢٥٪ فقط من الجرعة الموصى بها من سماد اليوريا.