



Effect of Plant Residues-Treated Urea on Growth and N-Uptake of Wheat (*Triticum aestivum* L.)

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Abstract: A pot experiment was carried out to study the effect of the urea fertilizer treated with corn or conocarpus residues on growth and N uptake of wheat plant. Three kilograms of dry soil (Silt clay loam) were placed in a plastic pots and four levels of nitrogen (0, 60, 120 and 180 kg N ha⁻¹) were added as urea. Urea was treated with one of the following methods : mix with the conocarpus leaves powder at rate of 4% of dry soil weight, mix with the conocarpus roots powder at rate of 4% of dry soil weight dissolved in, aqueous extract of the corn root at rate of 1/4 of the field capacity ,or coated with dried aqueous extract of corn root at ratio of 10% of urea weight. Treatment included urea treated with the standard chemical inhibitor (PMA) was used. shoot dry weight, N conc., N-uptake and N recovery were obtained. The results showed that treatment of urea fertilizer with water extract or coated with corn root extract resulted in improved growth parameters as compared with a PMA and control treatments .However ,treating urea with leaves or root powders decreased plant growth parameters .Urea coated with 10 % dried extract of corn roots gave the highest dry matter of 3.06 g pot⁻¹ and nitrogen uptake of 69.90 mg pot⁻¹ resulting in saving of 60 kg N ha⁻¹ to give the same results for control and PMA treatments.

Key words : Wheat, Corn Residue , Conocarpus Residue, Dry Matter ,N-Uptake.

Introduction

The production of cereals in the world is about 24988 million tons in 2014 .The share of wheat production is 707200000 tons, this consumed about 113100000 tons of nitrogen fertilizer which are expected to rise to 119400000 tons in 2018 with annual increase of 1.4% (FAO, 2015). Zhu & Chen (2002) reported that urea is one of the most solid nitrogen fertilizers consumed worldwide (more than 50% of total nitrogen fertilizers) due to its high N content (46%), low manufacturing cost, easy storage and handling. However, the rapid hydrolysis of-

NH₂ containing urea by urease leads to several problems including losses (volatilization, leaching and denitrification), toxicity of seeds and seedling when added in high doses , as well as possible contamination of water, air and soil (Trenkel, 2010). One of the important approaches to minimize N losses from urea and reduce the toxicity and pollution hence, rise urea fertilizer efficiency is using compounds inhibit urease activity in soil and delay urea hydrolysis. Numbers of chemical and organic compounds are available as urease inhibitors.

The damage caused by use of chemical inhibitors, as well as its high cost of manufacturing despite of their high efficiency at low concentrations, prompted the interested to search for alternative natural materials as urease inhibitors. The great challenge is to find natural substances with good properties that are nontoxic ,effective at low concentrations ,chemically stable when mixed with urea and urea solutions, highly degraded in soil and with competitive costs (Trenkel, 2010). Many plant residues have been tested as urease inhibitors in soil and have succeeded in reducing urea hydrolysis, reducing nitrogen loss and improving plant growth (Sivapalan *et al.*, 1983; Abdulkareem, 2006; Mohanty *et al.*, 2008; Patra *et al.*, 2009; Yaseen, 2010; Hoshan, 2012; Zhao *et al.*, 2015; Mathialagan *et al.*, 2017). The inhibitory effect of plant residues or plant extracts depends on the amount, quality of active substances in the plant and extraction methods.

Aqueous extracts of *Rhaza stricta* ,Myrtus leaves, Eucalyptus leaves, date palm fibre and sunflower inhibited urease when applied with urea and have been positive effect on the growth and yield of wheat, grass, radish and barley (Al-Mutlaq *et al.*, 2001; Abdulkareem, 2006; Naseem *et al.*, 2009). Results of Singh & Singh (1989) and Kiran & Patra (2002) showed that coating urea with neem oil ,mint oil, mint essential oil and mint terpenes resulted in a significant increases of growth, yield and N-uptake of wheat as compared with uncoated urea. The results of Al-Douri & Mohammad (2014) indicated that the presence of corn residues in the field at the level of 6 tons ha⁻¹ has improved the growth of wheat planted after maize, but increasing the level to 9 tons ha⁻¹ reduced plant dry weight to about 25%.

In previous study, a laboratory experiment was carried out at the College of Agriculture, Basrah University to study the effect of urea treated with leaves or root of corn (*Zea mays* L.) or conocarpus (*Conocarpus lancifolius* Engl) at different methods on activity of urease in calcareous soil (Al-Malaky & Abdulkareem, 2018). In present study the following treatments of urea that caused the highest inhibition of urease enzyme in soil were selected to study their effect on growth of wheat:

1. Conocarpus leaves powder mixed with urea and add at level of 4% based on soil dry weight.
2. Conocarpus roots powder mixed with urea and add at level of 4% based on soil dry weight.
3. Urea dissolved in aqueous extract of corn roots and added at level of 1/4 of soil field capacity
4. urea coated with dried aqueous extract of corn roots at ratio of 10% of urea weight and mix with soil .

Materials & Methods

Corn roots were collected in July and conocarpus residues (leaves and roots) were collected in April, cleaned, air-dried ,grinded, sieved then treated urea at the following methods:

- 1-Concarpus leaves powder was mixing with soil at rate of 4% based on soil dry weight, then urea added to the mixture at rate of 500 mg N. kg⁻¹ soil.
- 2-Concarpus roots powder was mixing with soil at rate of 4% based on soil dry weight, then urea added to the mixture at rate of 500 mg N. kg⁻¹ soil.
- 3-Aqueous extraction of corn root residues was prepared by mixing the residues with

distilled water at ratio of 1:10 (residue :water), shaking for 6 hrs. at 160 rpm then filtered. Urea at rate of 500 mg N kg⁻¹ soil was dissolved in the prepared extract and added to soil equivalent to ¼ of field capacity.

4-The extract prepared in method (3) was dried at 40 C . Urea at rate of 500 mg N kg⁻¹ soil was treated with castor oil at rate of 1% overnight then coated manually by the dried extract at ratio of 10% of urea rate.

The soil (Typic Torrifluvents) used in this study was collected from Al-Deir region,

north of Basrah province at a depth of 0-30 cm. Soil properties determined according to methods described by Black (1965) and Page *et al.* (1982) and presented in table (1). Three kilograms of air-dried soil was placed in plastic pot and treated with four levels of urea (0, 60, 120 and 180 kg ha⁻¹) with mentioned methods or coated with phenyl mercuric acetate (PMA) at ratio of 10% of Urea or untreated (control) .Pots were placed in greenhouse and wheat seeds (variety Ebaa 99) were shown in Nov.16, 2017. All the pots received 120 kg ha⁻¹ of P₂O₅ and K₂O

Table (1): General characteristics of soil used.

Property	Unit	Value
pH		7.73
E.C.	dS. m ⁻¹	4.00
CaCO ₃	g. kg ⁻¹	382
CEC	Cmole ⁽⁺⁾ kg ⁻¹	14.90
Available Phosphorus	mg. kg ⁻¹	20.00
Total nitrogen	g. kg ⁻¹	0.19
Organic matter	g. kg ⁻¹	3.44
C:N Ratio		22.17
Activity of urease	µg NH ₄ ⁺ -N g ⁻¹ Soil 2h ⁻¹	8.00
NH ₄ ⁺ -N	µg g ⁻¹	0.18
NO ₃ ⁻ -N		0.20
NO ₂ ⁻ -N		0.0
Ca ⁺²		14.3
Mg ⁺²		8.3
Na ⁺¹	m mol. L ⁻¹	18.00
K ⁺¹		2.00
HCO ₃ ⁻¹		2.30
SO ₄ ⁻²		25.09
Cl ⁻¹		8.00
CO ₃ ⁻²		0.00
S	g. kg ⁻¹	120.7
Silt		529.2
Clay		350
Texture		silty clay loam

as triple superphosphate and potassium sulfate, respectively. All fertilizers were applied by mixing at the time of sowing. Soil moisture was maintained at field capacity by periodic weight and compensated by the addition of water all over the experiment period. The statistical design followed a completely randomized design (CRD) with three replicates. After 60 days of sowing the

plant were harvested from soil surface and dry weight was measured. Nitrogen in plant shoot was determined by digestion with salicylic acid-H₂SO₄ mixture that described by Nelson & Sommers (1973), then the digest was analyzed by the Kjeldahl distillation method (Bremner, 1982). Uptake and recovery of N were calculated as the following :

$$N - \text{uptake} = \text{dry weight} \times N \text{ concentration in shoot}$$

$$N - \text{recovery \%} = \frac{N \text{ uptake from treatment} - N \text{ uptake from control}}{\text{Amount of N applied}} \times 100$$

All observations were subjected to the analysis of variance (ANOVA) by using SPSS V.14 program. The Revised least significant difference were calculated at 5% level for significant "F" test .

Results & Discussion:

Shoot dry weight :

The results of table (2) showed a significant increases in dry matter of wheat plant when urea treated with corn residues (Aqueous extract of corn root and coated urea) as compared with the untreated urea, with an increase per cents of 52 and 54 % respectively, with no significant difference between them. These increases in dry matter attributed to reduce urea hydrolysis (Al-Malaky & Abdulkareem, 2018) and decrease the ammonia volatilization of fertilizer, which increased the amount of available nitrogen in soil and affect the dry weight of the plant positively. This result was similar to that of Abdulkareem (2006), Yassin (2010) and Hoshan (2012) who obtained an increase in the dry matter of barley and maize when urea treated with aqueous extracts or coating with secondary metabolites of some plants.

Nitrogen plays an important role in the formation of chlorophyll, proteins and enzymes, and stimulates the production of oxin, which promotes cell division and proliferation, thereby increasing plant biomass and reversing the dry weight of the vegetative part (Barker & Bryson, 2007).

On the other hand , there are no significant differences at urea treated with conocarpus leaves or root as compared with untreated urea (table 2). Although, these two treatments caused higher inhibition of urease (Al-Malaky & Abdulkareem, 2018) and minimizing NH₃ volatilization, the negative effect on plant growth may attributed to direct effects of allelopathic substances, especially phenols derived from the decomposition of the powder and /or to indirect effects resulting from a defect in fertility of soil. Rice (1984) attributed the negative effect of plant extracts to the role of allelopathic compounds, especially phenols, in inhibiting the construction of porphyrin, compound responsible for the formation of chlorophyll. Cheng & Cheng (2015) also noted that plant-derived chemicals increase water stress and reduce water absorption by plant , as well as the inhibition of the ATPase co-enzyme

Table(2): Effect of the methods of urea treatment on shoot dry weight of wheat plant(g pot⁻¹).

Treatment	Urea level (kg N ha ⁻¹)				Mean
	0	60	120	180	
Conocarpus leaves Powder	0.75	1.87	2.24	2.33	1.79
Conocarpus root powder	0.75	2.00	3.00	2.73	2.12
Aqueous extract of corn roots	0.96	2.60	3.69	4.81	3.02
Coated urea	0.55	2.55	3.76	5.36	3.06
PMA	1.10	2.00	3.06	0.53	1.67
Control	0.80	2.06	1.82	3.30	1.99
Mean	0.81	2.18	2.92	3.18	
RLSD 0.05: treatment=1.02 ; level=0.68 ; treatment x level= ns					

which responsible for increasing the K⁺ / Na⁺ ratio in the plant tissue by controlling the permeability of these ions through plasmalema. All the urea treatments increased plant dry matter in comparison to PAM treatment (table 2), with more pronounced at treatments of aqueous extract and coated urea. Furthermore , untreated urea had higher dry matter as compared with PMA treatment.

The results were similar to those of Yassin (2010), Neghamish (2012) and Hoshan (2012) who obtained an increase of dry matter weight of maize, sorghum and barley when urea treating with water extracts or coating with secondary metabolites of some plants compared to chemical inhibitors such as HQ and ATS. This is due to the negative effect of PMA on plant growth, which is most pronounced at the high nitrogen level (table 2). That means the increasing of PMA as a result of increasing the level of urea will increased its negative effect on plant. Joo *et al.* (1992) pointed out that some chemical inhibitors (ATS and NBPT) inhibit enzyme activity only when added at high levels, resulting in a negative effect on plant growth. Trenkel (2010) confirmed this when he pointed out that one of the determinants of the use of the hydroquinone is its high toxicity to

the organisms. PMA (C₈H₈HgO₂) is a chemical compound containing mercury, which usually used to stabilize dyes. When PMA added to the leaves of plant, it is considered to be an inhibitory agent for transpiration because it alters the permeability of the guard cells and their functions. It is also used as an inhibitor for bacteria and fungus. In our study, increasing the addition of PMA at high levels of urea associated with increasing the amounts of mercury and phenol and may lead to a direct inhibitory effect on wheat plant the results of table (2) indicated that there was an increase in the dry matter of wheat plant with increasing the level of nitrogen the dry matter were 0.81, 2.18, 2.92 and 3.18 g pot⁻¹, for levels of 0, 60, 120 and 180 kg N ha⁻¹, respectively. The differences were significant between the three levels of urea and the control, as well as between the levels of 60 and 120 kg N ha⁻¹. This finding is similar to Eltelib *et al.* (2006), Babalar *et al.* (2010) and Selim *et al.* (2010). Although there is no significant effect of the interaction of treatment and N levels (table 2); it is noticed that treating urea with root or leaves of conocarpus gave the lowest dry matter at all levels of nitrogen, which confirms the negative role of the high addition of these

powders. The results of the interaction also showed an increase in dry matter by increasing the level of nitrogen up to 120 kg N ha⁻¹ at the treatment of PMA, while the dry matter decreased significantly to 0.53 g pot⁻¹ at level of 180 kg N ha⁻¹.

Nitrogen concentration in shoot of wheat plant

Table (3) shows that higher N concentrations were obtained in plant received urea treated with aqueous extract or coated with dry aqueous extract as compared with plant received untreated urea, with significant increase at coated urea. This is may be due to reduced ammonia volatilization and sufficient nitrogen uptake by the plant. Abdulkareem (2006) reported that treated urea with some plant extracts significantly reduce ammonia volatilization .However, other treatments gave lower N concentration as compared with untreated urea. Except that of conocarpus root powder treatment, all urea treatments gave higher N concentration in plant as compared with PMA treatment (table 3). Coating urea with dried aqueous extract had a significant increase with a percent of 17% as compared

with PMA treatment having a same trend of dry matter (table 2). This result is in accord with that of Negamish (2012) who reported a superiority of the treatment of urea treated with aqueous extracts over chemical inhibitors (HQ and ATS) in the concentration of nitrogen in sorghum leaves. Except that of conocarpus root powder treatment, all urea treatments gave higher N concentration in plant as compared with PMA treatment (table 3). Coating urea with dried aqueous extract had a significant increase with a percent of 17% as compared with PMA treatment having a same trend of dry matter (table 2). This result is in accord with that of Negamish (2012) who reported a superiority of the treatment of urea treated with aqueous extracts over chemical inhibitors (HQ and ATS) in the concentration of nitrogen in sorghum leaves.

The results of table (3) displayed a significant increase in concentration of nitrogen in leaves with an increasing rate of nitrogen. The differences were significant among all nitrogen rates, except for

Table (3): Effect of the methods of urea treatment on nitrogen concentration in shoot of wheat plant (g kg⁻¹ dry matter).

Treatment	Urea level (kg N ha ⁻¹)				Mean
	0	60	120	180	
Conocarpus leaves Powder	10.46	18.89	20.47	22.03	17.96
Conocarpus root powder	7.87	18.02	21.00	20.43	16.83
Aqueous extract of corn roots	11.88	18.20	22.00	23.93	18.95
Coated urea	11.02	25.88	22.30	24.66	20.96
PMA	13.63	18.35	19.93	19.90	17.95
Control	12.93	15.70	21.60	23.60	18.45
Mean	11.30	19.17	21.21	22.42	
RLSD 0.05 : treatment=1.90 ; level=1.87 ; treatment x level= ns.					

The difference between the levels of 120 and 180 kg N ha⁻¹. The nitrogen concentrations were 11.30, 19.17, 21.21 and 22.42 g. kg⁻¹ dry matter for levels 0, 60, 120 and 180 kg N. ha⁻¹, respectively. This is in agreement with results of Jameel (2012) who indicated an increase in the concentration of nitrogen plant by increasing the level of nitrogen.

Nitrogen uptake by wheat plant

Table (4) revealed that nitrogen content of plants fertilized with urea treated with the dried aqueous extract of corn roots or urea treated with aqueous extract of corn roots were higher than plant with untreated urea, with an increase percentages of 75 and 61 %, respectively. However, treated urea with shoot or root powder of conocarpus did not give a significant differences as compared with untreated urea. Results of Singh & Shivay (2003) and Haque & Majumdar (2005) showed a significant effect of neem

cake coated urea on N-uptake by rice and wheat. All urea treatments, as well as untreated urea increased the N uptake by wheat over the PMA treatments, with significant differences at treatment of aqueous extract and coating urea (table 4). Data presented in table (4) revealed that the increase in nitrogen rate led to an increase in the amount of nitrogen uptake with values of 9.49, 40.91, 63.37 and 72.94 mg. pot⁻¹ for levels of 0, 60, 120 and 180 kg N. ha⁻¹, respectively.

The results of table (4) showed that the addition of urea treated with aqueous extract or coating at a level of 120 kg N. ha⁻¹ resulted in a higher N-uptake than that of untreated urea and urea treated with PMA at the level of 180 kg N. ha⁻¹ which clearly shows the possibility of reduction of 60 kg N. ha⁻¹. These results confirm the possible use of corn residues as an alternative to PMA.

Table (4): Effect of the methods of urea treatment on nitrogen uptake by wheat plant (mg pot⁻¹).

Treatment	Urea level (kg N ha ⁻¹)				Mean
	0	60	120	180	
Conocarpus leaves Powder	8.23	28.37	45.85	52.03	33.62
Conocarpus root powder	5.41	36.04	63.00	56.06	40.12
Aqueous extract of corn roots	11.36	49.12	81.18	115.50	64.29
Coated urea	6.73	64.63	83.21	125.03	69.90
PMA	14.89	34.99	67.71	11.16	32.18
Control	10.34	32.34	39.31	77.88	39.96
Mean	9.49	40.91	63.37	72.94	

RLSD 0.05 : treatment = 20.72 ; level=15.06 ; treatment x level= 36.05

Similar results were obtained by Vyas *et al.* (1991) when he pointed out that coating urea with the extract of the neem reduced the amount of nitrogen used from 100 kg N. ha⁻¹ to 70 kg N. ha⁻¹ to give the same as the yield of the rice plant.

Nitrogen recovery of wheat plant

Table (5) explained that N recovery by wheat with urea treated with aqueous extract and urea coated with dried aqueous extract markedly increased compared to untreated urea. However, lower increases were recorded

in urea treated with shoot and root powder of conocarpus. Similar results have been reported by Blaise & Prasad (1996) and Hoshan (2012) who attributed this increase to the inhibition of urease activity and the availability of sufficient nitrogen in the soil reflected on the absorbed quantity as well as the improvement growth of the plant. As compared with PMA treatment, all treatments increased the N recovery by 30, 62, 129, 190

and 26% for treatments of shoot powder, root powder, aqueous extract, coated urea and uncoated urea, respectively (table 5).

Results showed that N recovery by wheat decreased by increasing urea level (table 5). At all urea levels, highest N recovery were obtained at treatment of coated urea with dried aqueous extract followed by treatment of urea treated with aqueous extract.

Table (5): Effect of the methods of urea treatment on nitrogen recovery of wheat plant (%).

Treatment	Urea level (kg N ha ⁻¹)			Mean
	60	120	180	
Conocarpus leaves Powder	30.43	20.90	16.10	22.47
Conocarpus root powder	33.44	31.99	18.75	28.06
Aqueous extract of corn roots	41.95	38.78	38.56	39.76
Coated urea	64.32	42.50	43.81	50.21
PMA	22.33	29.36	0.32	17.33
Control	24.44	16.09	25.01	21.84
Mean	36.15	29.93	23.75	

Conclusion

It can be concluded from this study that coating urea with the root extract of corn or addition of the aqueous extract of corn root with urea increased growth and uptake of nitrogen of wheat plant compared with untreated urea or treated urea with PMA, which clearly indicates the success of using corn residues as a suitable alternative to chemical inhibitor, as well as reduction of 60 kg N ha⁻¹ is of economic benefit and reduce the environmental risks.

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