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EFFECT OF ENRICHMENT BIOCHARE BY NITROGEN AND USED AS SLOW RELEASE FERTILIZER ON NITROGEN AVAILABILITY AND YIELD OF OKRA (*Ablemoscus esculentus* L. Moench) PLANT

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Abstract

A greenhouse experiment was conducted in agricultural research station - College of Agriculture / Garmat Ali campus during the winter season 2020 - 2021 in Silty clay soil under drip irrigation system, cultivated Okra crop *Ablemoscus esculentus* L. Monech, Hasnawi variety local production, to study the effect of different levels of Biochar enrichment by nitrogen and used as slow release fertilizer on nitrogen availability in soil and yield of Okra plant.

The study included an impact statement Iraqi urea fertilizer source of nitrogen (46 % N) as control and Biochar enrichment with nitrogen:

(NECB %100), (NECB %75 + N %25), (NECB %50 + N%50), (NECB %25 + N%75). Fertilizers apply as soil application when preparation soil in greenhouse before planting seeds, the results of this study showed:

The fertilizer of Biochar enrichment with 100% nitrogen (100% NECB) significantly superior on available nitrogen in soil by 23.28 gm Kg^{-1} at deep distance (0 - 25) cm deep and significantly superior of particle biochar size (2 mm) with15.33 gm Kg^{-1} respectively compared with other treatments during plant grown season. Also same treatment (100 % NECB) were significantly superior on total yield by values 8.12 ton ha^{-1} compared with other treatments during last period of plant growth respectively.

* The research as a part of MSC thesis of first author.

Key ward: Enrichment Nitrogen, Biochare, N availability, yield, Okra

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I. INTRODUCTION

Okra crop (Ablemoschus esculents L.) related to mallow family (Malvsceae) and consider the most important vegetables in the world, especially in tropical and semi tropical weathers (Marin et al., 2017). Okra occupies a prominent position between vegetables fruit due to easy cultivate and its capability of large adaptation with change of weather (Reddy et. al., 2012). Total area cultivated with Okra on 2019 - 2020 in Iraq around 64146 Donm with total yield attain 93719 Ton, while total yield for Basrah province was 1686 Ton for 2085 Donm (Statically Dept., Agriculture Ministry - Iraq, 2019 - 2020). Using high amount of fertilizers to increased Okra yield maybe effect dangerous on environmental (Attigah et al., 2013). So, been try to find new or alternatives fertilizers to increased Okra yield by used different composition of fertilizers (Akande et al., 2010). Usually used many thousands from nitrogen fertilizers in agricultural practicing at last year's mentioned to low efficiency of using nitrogen fertilizers (Ichami et al., 2018). High solubility of nitrogen fertilizers in soil such as Urea caused leaching nitrogen outside root zone and decreased of fertilizer used efficiency (AL-Ansary and AL-Hoshan, 2017), and possibility of causing ground water pollution. For the purpose of evolution yield response of crops due to increasing population in Iraq, the management of nitrogen fertilizers is the important and basically requirements (Smith et al., 2019, Jain et al., 2020 and Young et al., 2021). For solve high solubility of nitrogen problem, many researches conduct a new technology of enrichment or coated biochar by nitrogen, as the porous materials of biochar can be enrichment with nitrogen, so can coated by environmentally friendly materials and cheap. Enrichment with nitrogen consider a common operation in many countries in the world to achieve the highest production on field crops (Long et al., 2010). Biochar are a chemical materials that can produced through the pyrolysis process with / or without a limited value of oxygen (Domingues et al., 2017). Also biochar consider a material can improved physical, chemical and fertility soil properties (AL-Zubidy 2019, AL-Mousa 2020 and Shlish 2020). Because biochar has a high porosity and high specific area, so can keep or save a high concentration of nitrogen inside these porosity within different size and at the least enrichment with nitrogen liquid after drying (Liang et al., 2006).

II. MATERIALS AND METHODS

A greenhouse experiment was conducted in agricultural research station - College of Agriculture / Garmat Ali campus during the winter season 2020 - 2021 in Silty clay soil under drip system cultivated Okra crop *Ablemoscus esculentus* L. Monech, Hasnawi variety local production to study the effect of different levels of Biochar enrichment with nitrogen and used as slow release fertilizer on nitrogen availability in soil and some growth parameters, early and total yield of Okra plant. The study included an impact statement Iraqi urea fertilizer source of nitrogen (46 % N) as control and Biochar enrichment with nitrogen:

(NECB %100), (NECB %75 + N %25), (NECB %50 + N%50), (NECB %25 + N%75) at two size 1 (S1) and 2 mm (S2). Fertilizers apply as soil application before cultivate seeds in greenhouse. Samples from greenhouse soil were collect and estimate different physical and chemical properties as described by Black 1965, Jackson 1965 and page *et al*., 1982 and showed in table (1). Randomized complete block design was conduct of two factor with three replicates. Number of treatments was 10 and replicated three time, so the total was 30 experiment units, each area unit around 5 m^2 including 24

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plants. Okra seeds (Hasnawi verity) was sowing on 15/11/2020 within 5 seeds in one hole. After compete seeds germination, plants thinned to one plant / hole. Soil sample were taken from each experiment unit at deep (0 - 25) cm to estimate available nitrogen used KCl solution 2 *M* as described in Bremner and Keeny, 1966 method. Solution estimate using distillation steam system with heavy MgO and Devarda alloy, after that treated sample by Burck acid as described in Bremner and Edwards, 1965 method. All agricultural services were conduct on plant such as irrigation under drip system and spraying chemical control and collect total yield start from first harvest after flowering till end season.

Table (1): Some physical and chemical properties for experiment soil

Adjective	Value	Unit	Adjective	Value	Unit
pH	8.05	--	Ca^{++}	18.8	meq.L^{-1}
E.C	5.60	dSm^{-1}	Mg^{++}	15.5	
CEC	13.98	Cmol Kg^{-1}	Na^{+}	36.5	
Avai. N	4.20	mg Kg^{-1}	K^{+}	1.65	
Avai. P	11.02		HCO_3^{-}	5.44	
Avai. K	115.16		CO_3^{-}	0.00	
O. C	3.97	gm Kg^{-1}	Cl^{-}	34.45	
O. M	0.69		$SO_4^{=}$	26.67	
Real Density	2.65	Mgm Kg^{-3}	Sand	112	Silty clay
Bulk Density	1.62		Silt	433	
Total N	0.35	gm Kg^{-1}	Clay	455	

III. RESULTS AND DISCUSSION

Available Nitrogen (0 - 25) cm in soil:

Figure (1) showed the effect of apply different biochar enrichment with nitrogen treatments on available - N in (0 - 25) cm of Okra field soil. Results showed a significant superiority of all biochar enrichment with nitrogen treatments compared with control treatment (apply only Urea) during plant growth period and with a direct increase after the first stage of plant age (November). The highest rate of available - N in soil was at before the last stage of estimated (March) and attain 23.98, 20.31, 15.58, 10.67 and 8.80 gm Kg^{-1} for treatments: (100% NECB), (75% NECB + 25% N), (50% NECB + 50% N), (25% NECB + 75% N) and control respectively.

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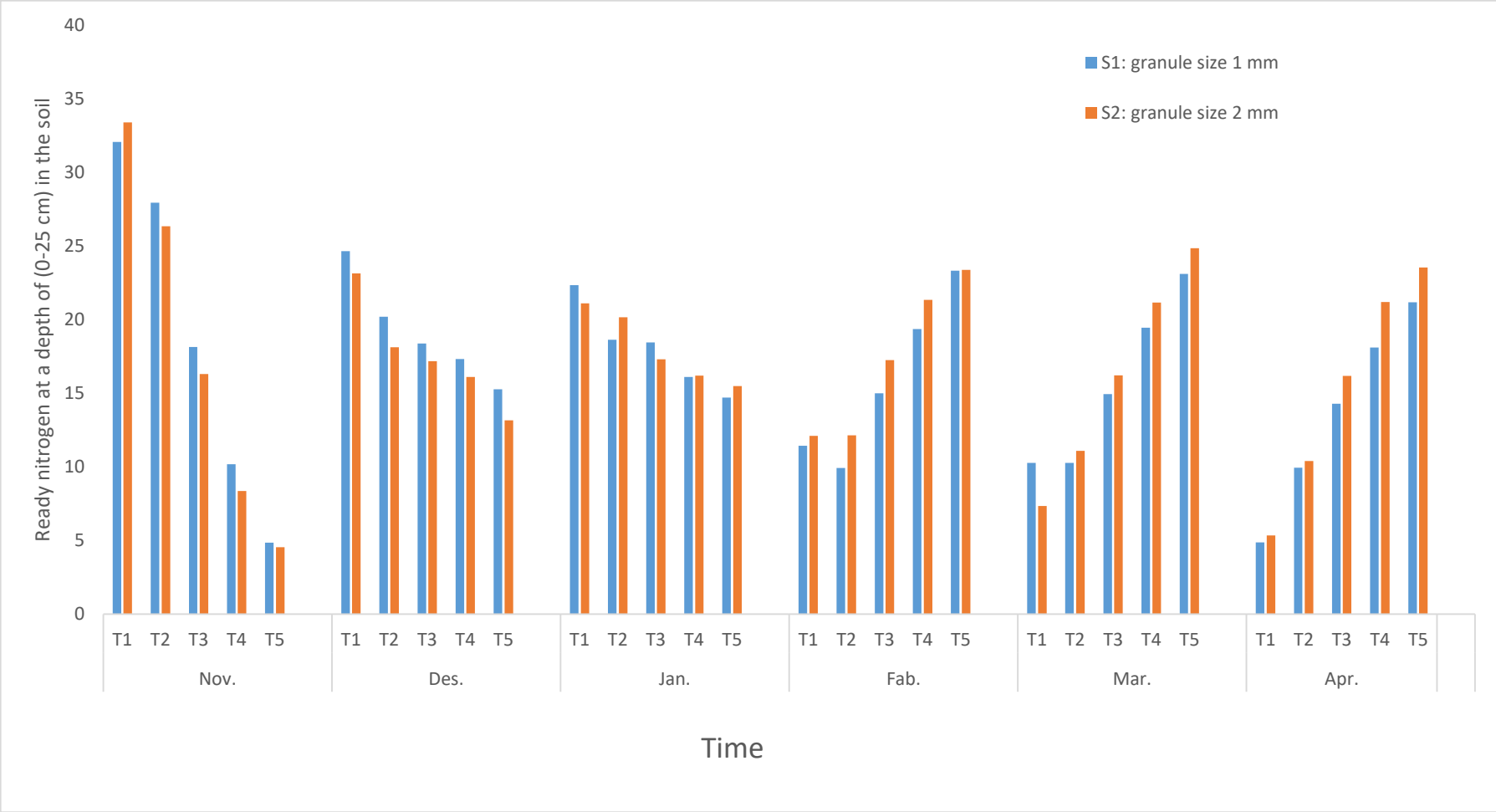

Fig. 1: Effect of biochar enrichment with nitrogen treatments and particle coated size on available - N gm Kg^{-1} in (0-25)cm soil during Okra plant growth season.

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Highest rate of available - N was at treatment (5) 100% NECB on March and attain rate 23.98 gm Kg^{-1} with a significant difference of other treatments, with an percentage increase of 0.22, 25.71, 78.23 and 94.03 % for treatments: (75% NECB + 25% N), (50% NECB + 50% N), (25% NECB + 75% N) and control respectively. It is clear from the Fig. 1, that increasing of available-N in (0 - 25) cm in soil for okra plant on first and second period (November and December) from growth season was for apply nitrogen by 100% N (T1), 75% NECB + 25% N (T2) and 50% NECB + 50% N (T3) respectively due to high solubility of nitrogen in these treatments and increased concentration on nitrogen in soil solution, after this period the rate of nitrogen concentration start decreased due to leaching very deep outside of plant root zone and increased uptake by Okra plant. While nitrogen concentration increased in treatments: 75% NECB + 25% N (T4) and 100% NECB (T5) on last period of estimate (February, March and April) due to slow dissolution and release gradually small amounts of nitrogen from these treatments in soil solution. Treatment of 100% NECB (T5) was the most efficient among the other treatments to providing appropriate concentration of available -N in soil solution due to including or full enrichment with nitrogen and release nitrogen slowly during Okra growing season (Kelly *et al*., 2015 and Zheng *et al*., 2016), also biochar enrichment with 100% nitrogen worked on improved the physical and chemical properties that can make soil aggregate and hold appropriate water help to dissolved nitrogen (Solaimann *et al*., 2015 and Rasul *et al*., 2017). Also data in Fig. 1 showed effect of particle size of coated biochar enrichment with nitrogen on available-N in (0 - 25) cm soil for Okra plant, were appear a significant differences between coated size 2 mm (S2) were attain 15.33 gm Kg^{-1} compared with 1 mm size (S1) attain 13.67 gm Kg^{-1} at treatment 100% NECB especially at last period of estimate (April). The reason for that maybe related to high storage space which this size have it and keep as much as possible of nitrogen inside this size and decreased nitrogen leaching or volatility from soil solution and keep release nitrogen very slowly to soil solution during plant growth season. For interaction effect between biochar enrichment with nitrogen and coated particle size, data showed no significant differences on available - N.

Total yield (Ton ha^{-1}):

Data in table (2) showed the results of effect apply different biochar enrichment with nitrogen treatments on Okra total yield, data showed a significant superiority of all biochar enrichment with nitrogen treatments compared with control treatment (apply only Urea) during Okra harvest periods. Highest total yield attain at rate 8.12 Ton ha^{-1} for 100% NECB treatment compared with a significant difference with 6.53, 6.76, 7.18 and 7.95 Ton ha^{-1} for other treatments: control, (25% NECB + 75% N), (50% NECB + 50% N) and (75% NECB + 25% N), with an percentage increase of 24.35, 16.23, 9.95 and 3.52 % respectively. Increasing total yield of Okra plants during growing season maybe due to applied different treatments of biochar enrichment with different percent of nitrogen and led to increased nitrogen availability (Fig. 1) and reflection of it on morphological Okra plant properties such as increased roots growth and increased of its ability to uptake a high amount of available - N from soil

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solution. Treatment of 100% NECB (T5) was the most efficient among the other treatments to providing appropriate concentration of available -N in soil solution (Fig. 1) due to including or full enrichment with nitrogen and release nitrogen slowly during Okra growing season (Kelly *et al*., 2015 and Zheng *et al*., 2016), and this reasons led to high uptake and metabolism of nitrogen inside Okra plant and formation of flowers and increase of fruit pods. This results agree with results of Ghosh *et al*., 2020 and Alsoufi *et al*., 2020.

Table 2: Effect of biochar enrichment with nitrogen treatments and particle coated size on Okra total yield (Ton ha^{-1}).

	Biochar (%)					Mean
	T1	T2	T3	T4	T5	
S1	6.50	6.65	6.76	7.27	7.87	7.01
S2	6.55	6.87	7.59	7.92	8.37	7.64
Mean	6.53	6.76	7.18	7.59	8.12	
LSD 0.05	S		T		T x S	
	1.73**		2.74**		n.s	

Also data in table (2) showed the effect of particle size of coated biochar enrichment with nitrogen on Okra plant total yield, were appear a significant differences between coated size 2 mm (S2) were attain 7.46 ton ha^{-1} compared with 1 mm size (S1) attain 7.01 ton ha^{-1} at treatment 100% NECB with especially with an percentage increase of 6.42 % on harvest period. The reason for that maybe related to high storage space which this size have it and keep as much as possible of nitrogen inside this size and decreased nitrogen leaching or volatility from soil solution and keep release nitrogen very slowly to soil solution during plant growth season,which led to increased nitrogen availability in soil (0 - 25 cm) near Okra plant root and uptake nitrogen element easily, transfer and metabolism inside plant cell and reflection that on total yield. For interaction effect between biochar enrichment with nitrogen and coated particle size, data showed a significant superiority of interaction on total yield, were treatment of 100 % NECB and particle coated with size 2 mm (S 2) was the most efficient and significant among the other treatments in Okra total yield where attain a highest value 8.38 ton ha^{-1} compared with other size 1 mm (S1) with an percentage increase of 27.87 % (Shalish, 2020).

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:-

1- The experiment showed the addition of 100 % NECB lead to significant increase on available -N in (0 - 25) cm in soil and total yield of Okra plants.

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2- Coated particle biochar enrichment with nitrogen within 2mm, was the best coating compared with particle size 1 mm.

Recommendations

1- Add bichoar enrichment with 100 % nitrogen to plant before planting seeds.
2- Apply biochare enrichment with nitrogen to different vegetables under the southern of Basrah soil conditions.

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