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Research Article

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Under Long Term Experiment, Response of Different Doses of Phosphorus Application on Wheat and Soil Content of Carbon and Nitrogen

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ABSTRACT
A Long-term field experiment was established at the University of Çukurova, Research and Application field of Agriculture Faculty on soil of Arıklı series at 1998. Four P doses such as; 0 (P0) as control, 50 (P50), 100 (P100) as well as 200 kg P_2O_5 ha^{-1} (P200) were applied with tree replications. Wheat of Adana-99 species *(Triticum aestivum L.*) seeds were sown in November 2018 and harvested at May 2019. After harvesting, plant sample and soil samples under different depth and places (0-15 and 15-30 cm soil depth in Rhizosphere and Non-Rhizosphere) were taken. Root, shoot and seed part of wheat and soil C and N sample analyzed by Fisher 2000 model CN analyzer. The Organic Carbon (OC) and Total N (TN) pools were calculated by Ortas and Lal, 2012. Obtained data statistically analyzed and LSD test were realized by JMP 8 computer package program. There was statistically significant difference as N% and C% concentration under P200 doses application. The heights C% and N% concentration was determined with P200 treatment. Also, there was statistically significant different as soil OC amount in Rhizosphere 0-15 soil depth in P 200 doses treatment in which the highest carbon content 46.1 Mg ha^{-1} was determined. In addition, soil total nitrogen was determined and the highest N was measured in 0-15 cm soil depth. Soil C:N ratio changing from 6.1 to 10.3 and the highest C:N ratio was determined in Non-Rhizosphere 15-30 cm soil depth. Under long-term field conditions, depending on increasing doses P fertilizer wheat plant growth and increased plant N and C concentration. Also, soil OC and TN amount were increased. It seems that the addition of P dose application increased biomass and consequently plant and soil C content. This is supporting our hypothesis.
Keywords: Long-term experiment, Phosphorus, Wheat, Soil Organic Carbon, and Nitrogen.

INTRODUCTION

Wheat (*Triticum aestivum* L.), is one of the most produced plants in the world (FAOSTAT, 2020). Wheat has rich nutritive that contains vitamins, minerals, and amino acids (Shewry, 2009). Phosphorus fertilizer is one of the most consumed fertilizers in terrestrial plant (like wheat) production after than Nitrogen (N) (Güzel et al., 2002).

The world population is expected to be 9.8 billion by 2050, which requires the agricultural production to rise, by 70%. In the past decades, the use of P fertilizers has enhanced the food production and facilitated feed billions of people all over the world (Wang and Lambers, 2020). Insufficient P fertilization will not occur in plant production, and in case of excessive P fertilization, it will cause eutrophication (Frossard et al., 2016). P is a fundamental component of nucleic acids, phospholipids and ATP (Haneklaus and Schnug, 2016). In addition, along with P fertilization, soil C and N content are important for the physical, chemical and biological fertility of the soil (Işık et al., 2020a). Pessimistic calculations world Preserves will have finish last only for another 50–150 years, thus P is not a sustainable source (Schnug and De Kok, 2016). We must use true P doses for sustainable and ecofriendly production. There are so many studies related to each other soil carbon (C), nitrogen (N), and phosphorus (P) content (Işık et al., 2020b; Melillo et al., 2003; Tian et al., 2010).

Soil organic carbon (specifically organic matter of soil) has used as a crucial point of soil health. Soil organic carbon is related to plant growth and the availability of mineral nutrients such as nitrogen (N) and phosphorus (P). However, still there is limited literature about relationship between soil organic carbon and phosphorus (P) nutrition. The biogeochemical progressions of N and C have narrowly together for terrestrial ecosystems. For instance, high N supplies during photosynthesis, joined in many terrestrial ecosystems using low N accessibility, means that growths in main production are dependent on the accessibility of N to fuel improved photosynthetic C gaining (Cleveland and Liptzin, 2007). In addition, soil C and N amount and ratio are effected soil microbial activity and mineralization (Jingguo and Bakken, 1997). Soil C and N contents since management practices (like fertilizer, irrigation and tillage applications) naturally occur in agricultural systems due to damage caused by

more sensitive and complex (Qiu et al., 2010). Still, there was so limited literature about soil C, N and P relationship.

Research aims to examine effects of different P doses application on soil and plant C and N concentrations. In this respect since phosphorus, increase plant biomass the hypothesis to be tested is; increasing P application contribute to plant and soil C and N pool.

MATERIALS AND METHODS

A field experiment was established as Long term at University of Çukurova, Research and Application field on Arıklı soil series at 1998 in Adana. Four P doses like as; 0 kg P_2O_5 ha^{-1} (P0) as Control, 50 kg P_2O_5 ha^{-1} (P50), 100 kg P_2O_5 ha^{-1} (P100), and 200 kg P_2O_5 ha^{-1} (P200) with tree replications were applied. Wheat *(Triticum aestivum L.*) species of Adana-99 seeds were sown in November 2018 and harvested at May 2019.

After harvesting, plant samples and soil samples under different depth (0-15 and 15-30 cm) in Rhizosphere(R) soil and Non-Rhizosphere (NR) soil were taken. Root, shoot, and seed part of wheat and soil C and N sample analyzed by Fisher 2000 model CN analyzer. The Organic Carbon (OC) and Total N (TN) pools were calulated flloing equation (Lal et al., 1998; Ortas andLal 2012):

$$\text{Mg OC or TN ha}^{-1} = \frac{\%\ \text{C r N x soil depth (m) x Pb (Mg m}-3\ \text{x 104 m2 ha}-1}{100} \quad (1)$$

Table 1. Some physical and chemical properties of Arık series soil (Turgut and Koca, 2019)

Soil Properties		Results
pH	(sat.)	7.63
EC	(mmhos cm^{-1})	0.06
lime	(%)	27.2
Organic Matter	(%)	1.17
	Kum	17
Texture (%)	Silt	28
	Kil	55
Texture Classification		C
P_2O_5	(kg da^{-1})	7.11

RESULTS AND DISCUSSION

Impact on Different Doses P Application on Plant Parts C and N Concentration

Impact on different doses P fertilizers application on different plant parts (root, shoot, and seed) C and N concentration shown in table 2. When looked table 2 that there was statistically significant difference as root and seed %N concentration. Both of them P200 application has best application compared to others. As shoot N and all parts C concentration P200 application best application on average. It can be possible from that depend on increasing P application plant N uptake and C fixation by photosynthesis increase.

Table 2. Impact on different doses P application on plant parts (root, shoot and seed) C and N concentration.

Applications	Root	Shoot	Seed
	TN (%)		
P0	0.60±0.18b	0.99±0.11	1.76±0.03b
P50	0.79±0.19ab	1.07±0.15	1.73±0.01b
P100	1.11±0.26a	1.150.16	1.90±0.10b
P200	1.14±0.12a	1.10±0.18	2.13±0.19a
	P<0.05	P>0.05	P<0.01
	TC (%)		
P0	18.8±4.27	37.71±2.55	30.68±0.72
P50	21.4±5.85	38.50±4.80	32.85±1.58
P100	26.6±0.47	38.96±4.38	33.03±1.16
P200	27.0±2.36	41.77±4.48	35.83±3.82
	P>0.05	P>0.05	P>0.05

For example; Tanwar et al. (2013) investigated the effects of increasing doses of P application and mycorrhizal inoculation on plant growth, N content, and photosynthesis activity. The research findings of the study show that compered to control P application increase plant growth percentage N content and photosynthesis activity. Also, Muhammad et al. (2020) in their work show that they applied five different P doses (0, 10, 20, 40, 80, 100 kg ha^{-1}) on broadcasting, and depend on increasing doses P application also yield an increase.

Impact on Increasing Doses P Application on soil Organic Carbon (OC), Total Carbon (TC), and Total Nitrogen (TN) content

Impact on increasing doses P application on soil IC, OC and TC showed Table 3. There was no statistically significantly different (P>0.05) for IC. Soil lime ($CaCO_3$) content is not one of them easily changing properties of the soil. Therefore, soil IC content is also one of the properties of the soil that does not change in a short time.

When we observe the effect of increasing doses of P applications on soil OC content, there was a statistically significantly difference at R 0-15. P 200 doses had the highest OC content. Because increasing doses of P fertilizers compared to control could increase the soil OC content. The stubble waste is also an organic carbon source (He et al., 2015). In addition, root secretions (like alcohols, enzyme activity, and phenol compounds) and microbial activity take place as OC source (Van Aken, 2011), therefore, it is expected that the TC content can be high.

In terms of TC content, there was a statistically significantly difference on surface soil (R 0-15 and NR 0-15). Depending on increasing P fertilizers, also plant biomass can increase and grow. It could increase stubble waste and TC content on the soil surface. The study of Işık et al. (2020b) suggests our finding.

Table 3. Impact on increasing doses P application on soil IC, OC, and TC concentration.

Applications	R 0-15	R15-30	NR 0-15	NR15-30
	% TC			
P0	4.35±0.43b	4.82±0.04	4.65±0.18b	5.64±0.42
P50	5.13±0.36a	4.85±0.04	4.74±0.26a	5.72±0.58
P100	5.41±0.06a	4.83±0.58	5.51±0.44a	5.29±0.05
P200	5.66±0.34a	5.07±0.53	5.01±0.27a	5.55±0.53
	P<0.01	P>0.05	P<0.05	P>0.05
	% OC			
P0	1.27±0.20b	1.53±0.10	1.46±0.19	2.17±0.40
P50	2.00±0.42a	1.71±0.10	1.48±0.43	2.28±0.51
P100	2.05±0.25a	1.81±0.09	1.79±0.26	1.93±0.31
P200	2.46±0.47a	1.92±0.46	1.87±0.34	2.30±0.24
	P<0.05	P>0.05	P>0.05	P>0.05
	% IC			
P0	3.23±0.17	3.19±0.15	3.19±0.22	3.47±0.04
P50	3.13±0.14	3.03±0.23	3.26±0.32	3.43±0.24
P100	3.36±0.22	3.34±0.21	3.62±0.12	3.35±0.29
P200	3.33±0.28	3.16±0.08	3.06±0.16	3.25±0.33
	P>0.05	P>0.05	P>0.05	P>0.05

Depending on increasing doses of P application there was a statistically significantly difference for soil TN concentration at R 15-30. Depending on root activity, microbial activity, and residual effect soil N concentration can be increased.

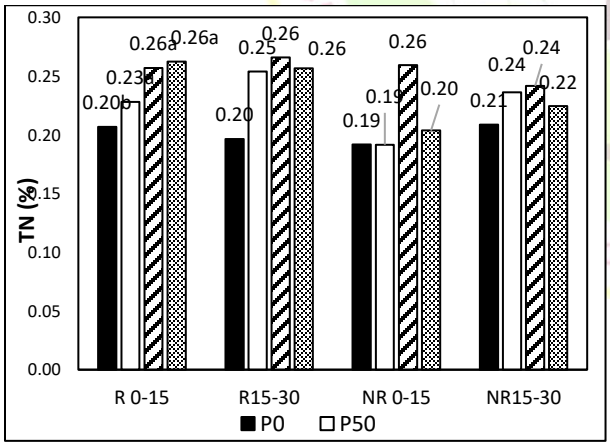

Figure 1. Impact on increasing doses P fertilizers on Soil TN Concentration.

Impact on Increasing P Doses on Soil TC, TN Amount, and C: N Ratio:

Soil organic matter (as OC source) has been used as an essential indicator of soil quality (Weil, 2004). The soil C dynamic has related to the availability of Nitrogen (Bykova and Ortas, 2020). The results of collective doses P fertilization on soil characteristics are obtainable in Figure 2. There was a statistically significant difference as soil OC amount R 0-15 application P 200 doses had the best application (with 46.1 Mg ha^{-1}) and on average at different depth and place Impact on increasing P application had a positive effect on soil OC amount.

While most soil C accumulation models use C: N ratios, relying on N application has prone to increase microbial activity. In Figure 2, increasing doses P application statistically affected soil different depth C: N ratio as R 15-30 and NR 0-15. C: N ratio was changed from 6.1 to 10.3 and the highest application is P200 doses. Expect of C: N ratio R 0-15 cm depth had statistically significant different and P 200 doses have highest C: N ratio for R 0-15 cm depth. Results are in parallel with suggested C:N ration by Batjes (1996); Van Groenigen et al. (2017); (Bykova and Ortas, 2020). In general mean of soil C: N ratios of soil organic matter range between 9.9 for arid soil and 25 for Histosols (Batjes 1996).

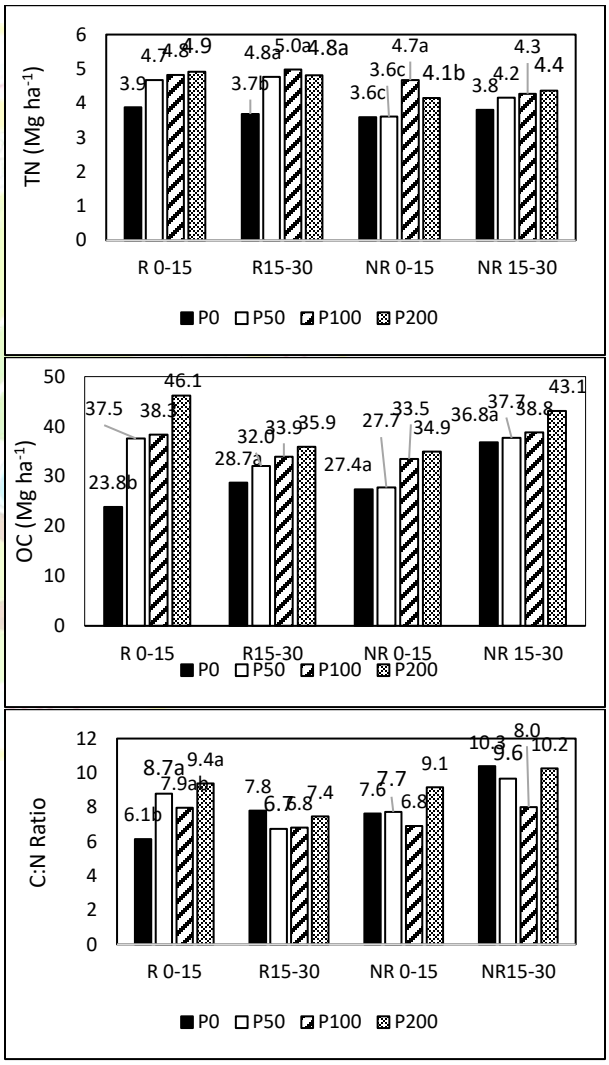

Figure 2. Impact on increasing P doses on Soil TN Amount (Mg ha^{-1}), OC Amount (Mg ha^{-1}) and C:N Ratio

CONCLUSION

Under long-term field conditions, depending on increasing doses of P fertilizer wheat plant growth and increased plant N and C concentration. Also, soil OC and TN amounts were increased. It seems that the addition of P dose application increased biomass and consequently plant and soil C content. This is supporting our hypothesis.

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