

CONTENTS

	Page
LIST OF TABLES.....	IV
LIST OF FIGURES	VI
INTRODUCTION.....	1
REVIEW OF LITERATURE.....	3
2.1. Silicon forms and status in soils	3
2.2. Silicon adsorption on soil	7
2.3. Factor affecting silicon transformation in soils.....	11
2.4. Silicon benefits to plants	12
2.4.1. Silicon and plant biomass	14
2.4.2. Silicon concentration and uptake by plants	16
2.5. Phosphorus availability in soil.....	17
2.6. Phosphorus and plant growth.....	19
2.6.1. Phosphorus and plant biomass.....	19
2.6.2. Phosphorus concentration and uptake by plants.....	20
2.7. Silicon and phosphorus interaction in soil.....	21
2.8. Silicon and phosphorus interaction and their effect on plant growth.....	24
2.8.1. Silicon and phosphorus interaction and their effects on plant biomass.....	24
2.8.2. Interactions effects of Si and P on their concentration and uptake of it's by plant.....	24
MATERIALS AND METHODS.....	26
3.1. Incubation experiments.....	26
3.1.1. First incubation experiment	26
3.1.2. Second incubation experiment.....	27
3.2. Adsorption experiments	29
3.2.1. Silicon adsorption experiments.....	30
3.2.2. Silicon and phosphorus interaction experiments	30

II

3.3. Cultivation pot experiments.....	32
3.3.1. Silicon cultivation pot experiment	32
3.3.2. Phosphorus cultivation pot experiment	32
3.3.3. Silicon and phosphorus interaction cultivation pot experiment.....	32
3.4. Statistical analyses.....	33
RESULTS AND DISCUSSION.....	34
4.1. Incubation experiments	34
4.1.1. Silicon and phosphorus availability as affected by silicon applied rate.....	34
4.1.1.1. Silicon availability.....	34
4.1.1.2. Phosphorus availability	35
4.1.2. Silicon and phosphorus interaction in the incubated soil	36
4.1.2.1. Silicon availability as affected by silicon and phosphorus application.....	36
4.1.2.2. Phosphorus availability as affected by silicon and phosphorus application.....	38
4.2. Adsorption Experiments	39
4.2.1. Silicon adsorption from the concerned solution contained different concentration of silicon	40
4.2.1.1. Silicon adsorption onto soil incubated with different silicon.....	40
4.2.1.2. Silicon adsorption onto soil incubated with different silicon and phosphorus concentrations.....	47
4.2.2. Silicon adsorption from the concerned solution contained different silicon and phosphorus concentrations onto the incubated soil.....	57
4.2.2.1 Silicon adsorption onto soil incubated with different silicon concentrations	57
4.2.2.2. Silicon adsorption onto soil incubated with different silicon and phosphorus concentrations.....	63

III

4.3. Cultivations pot experiments	72
4.3.1. Status of silicon and phosphorus in soil.....	72
4.3.1.1. Silicon availability as affected by silicon application to	72
4.3.1.2. Phosphorus availability as affected by Phosphorus	
application to soil.....	73
4.3.1.3. Silicon and phosphorus availability as affected by silicon	
and phosphorus interaction to soil	74
4.3.2. Plant growth.....	76
4.3.2.1. Silicon and phosphorus application effects on wheat	
biomass production	76
4.3.2.1.1. Silicon application effects	76
4.3.2.1.2. Phosphorus application effects	78
4.3.2.1.3. Silicon and phosphorus interactions effects	79
4.3.3. Silicon and phosphorus status in the grown plants.....	81
4.3.3.1. Silicon application effects on silicon status in plants.....	81
4.3.3.2. Phosphorus application effects on Phosphorus status in	
plants	83
4.3.3.3. Silicon and phosphorus interaction effects on silicon and	
Phosphorus status in plants	84
SUMMARY.....	89
REFERENCES.....	93
ARABIC SUMMARY	

LIST OF TABLES

No.	Page
1 Some physical and chemical properties of the studied soil	27
2 Available silicon as affected by silicon and phosphorus application to incubated soil samples	37
3 Available phosphorus as affected by silicon and phosphorus application to incubated soil samples.....	39
4 Freundlich isotherm parameters for adsorption of silicon onto soil samples incubated with different silicon concentrations.....	47
5 Freundlich isotherm parameters for silicon adsorption onto soil samples incubated with different silicon and phosphorus concentrations.....	56
6 Freundlich isotherm parameters for silicon adsorption under different phosphorus concentration by soil incubated with different silicon concentrations.....	62
7 Freundlich isotherm Parameters for silicon adsorption under different phosphorus concentration by soil samples incubated with different silicon and phosphorus concentrations.	70
8 Available silicon at booting growth stage of wheat plants as affected by silicon application to soil samples.....	72
9 Available phosphorus at booting growth stage of wheat plants as affected by phosphorus application to soil samples.	73
11 Fresh and dry weights of shoots and roots of wheat plants at booting growth stage as affected by silicon application to soil samples.....	77

12	Fresh and dry weights of shoots and roots of wheat plants at booting growth stage as affected by phosphorus application to soil samples.....	78
13	Fresh and dry weights of shoots and roots of wheat plants at booting growth stage as affected by silicon and phosphorus application to soil samples.....	80
14	Concentration and total content of silicon in shoots and roots of wheat plants at booting growth stage as affected by silicon applications to soil samples.....	81
15	Concentration and total content of phosphorus in shoots and roots of wheat plants at booting growth stage as affected by phosphorus applications to soil samples.....	83
16	Concentration and total content of silicon in shoots and roots of wheat plants at booting growth stage as affected by silicon and phosphorus applications to soil samples.....	85
17	Concentration and total content of phosphorus in shoots and roots of wheat plants at booting growth stage as affected by silicon and phosphorus applications to soil samples.....	86
18	Relationship between silicon and phosphorus concentration in shoots and roots of wheat plant and available Si and P concentration in soil samples.....	87

LIST OF FIGURES

No.	Page
1 Available silicon as affected by silicon application to soil under incubated condition.....	35
2 Available phosphorus as affected by silicon application to soil under incubated condition.....	36
3 Adsorbed silicon as affected by either applied silicon concentration in the concerned solution or applied plus initially available silicon concentration onto soil samples incubated with different silicon concentrations.....	41
4 Adsorbed silicon as affected by equilibrium silicon concentration in the concerned solution onto soil samples incubated with different silicon concentrations.....	41
5 Equilibrium silicon concentration as affected by either applied silicon concentration in the concerned solution or applied plus initially available silicon concentration in soil samples incubated with different silicon concentrations.....	42
6 Langmuir isotherm for silicon adsorption onto soil samples incubated with different silicon concentrations.....	44
7 Freundlich isotherm for silicon adsorption onto soil samples incubated with different silicon concentrations.....	45
8 Adsorbed silicon as affected by either applied silicon concentration or applied plus initially available silicon concentration in the concerned solution onto soil samples incubated with different silicon and phosphorus concentrations.....	48
9 Adsorbed silicon as affected by equilibrium silicon concentration in the concerned solution onto soil samples incubated with different silicon and phosphorus concentrations.....	50

VII

10	Equilibrium silicon concentration as affected by either applied silicon concentration or applied plus initially available silicon concentration in the concerned solution in soil samples incubated with different silicon and phosphorus concentrations.....	52
11	Freundlich isotherm for silicon adsorption onto soil samples incubated with different silicon and phosphorus concentrations.....	54
12	Response of silicon adsorption to either applied silicon or applied plus initially available concentration under different phosphorus concentrations in the concerned solution by soil samples incubated with different silicon concentrations.....	58
13	Response of silicon adsorption to equilibrium silicon concentration under different phosphorus concentrations in the concerned solution by soil samples incubated with different silicon concentrations.....	58
14	Response of equilibrium silicon concentration to either applied or applied plus initially available silicon concentration under different phosphorus concentrations in the concerned solution by soil samples incubated with different silicon concentrations.....	60
15	Freundlich isotherm for silicon adsorption under different concentration of phosphorus by soils incubated with different silicon concentrations.	61
16	Response of silicon adsorption to either applied silicon or applied plus initially available concentration under different phosphorus concentrations in the concerned solution by soil samples incubated with different silicon and phosphorus concentrations.	64
17	Response of silicon adsorption to equilibrium silicon concentration under different phosphorus concentrations in the concerned solution by soil samples incubated with	

VIII

	different silicon and phosphorus concentrations.....	65
18	Response of equilibrium silicon concentration to either applied silicon or applied plus initially available concentration under different phosphorus concentrations in the concerned solution by soil samples incubated with different silicon and phosphorus concentrations.....	67
19	Freundlich isotherm for silicon adsorption under different concentration of phosphorus by soil samples incubated with different silicon and phosphorus concentrations.....	69
20	Available silicon and phosphorus as affected by silicon and phosphorus application to soil samples at booting growth stage of wheat plants.....	75
21	The relationship between available silicon concentration in soil and silicon concentration in shoot and root of wheat plants.....	82
22	The relationship between available phosphorus concentration in soil and phosphorus concentration in shoots and roots of wheat plants.....	84

ABSTRACT

Heba Yahya Ahmed Saad: Studies of Silicon Behavior in both Soil and Plant Including the Interactions with Phosphorus. Unpublished Ph.D., Thesis, Soils Dept., Fac. Agric., Ain Shams Univ., 2018.

Multi-series incubation experiments followed by short term adsorption experiments and pot experiments were conducted to study the behavior of silicon (Si) and its interactions with phosphorus (P) in a clay soil.

The results declared that the availability of Si increased by increasing of the added amount up to 50mg Si Kg⁻¹, and decreased afterwards. Also, the availability of P increased by increasing the added amount of Si to soil.

Responses of adsorption rate of Si to certain environmental conditions were studied, such conditions being the applied ion concentration in the concerned solution, equilibrium concentration and interaction with P, by applying Freundlich as well as Langmuir isotherm. However, Freundlich isotherm gave good fit with the data than Langmuir isotherm. Hence, investigations were performed through evaluating the responses of ion adsorption to ion concentration in the concerned solution, these studies being carried out through evaluation of both adsorptive capacity (K_f) and the intensity of adsorption or sorption energy constant of Freundlich isotherm model ($1/n$). Results showed that the amount of adsorbed Si onto soil increased with increasing either the applied or equilibrated Si concentration in all incubated soil samples. Also, silicon adsorption onto soil decreased in the soil which incubated with high than with low Si concentration. As well as, application of P to the soil decreased the amount of adsorbed Si on all incubated soil samples.

The responses of growth, element status at booting growth stage of wheat plant to the applied Si and P together with their interactions were

followed. Obtained results showed that silicon and phosphorus were favorable, for plant growth, it increased with increasing Si or P concentration. Increasing the applied Si or P concentration to soil increased the fresh and dry weights of wheat plants at booting growth stage. In general, positive significant responses to the applied Si or P concentrations to soil were found in the status of Si or P in the grown wheat plants. Moreover, the interaction between Si and P applications at booting growth stage of wheat plants generally increased the growth parameters. Such responses were significant for fresh weight and dry weight.

Key words: Silicon, Phosphorus, Incubation, Adsorption, Freundlich isotherm, Wheat, Plant growth.