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EFFECTS OF PLANT VARIETY AND FERTILIZATION TYPE ON VEGETATIVE GROWTH AND NUTRITIONAL CONTENTS IN COWPEA *VIGNA UNGUICULATA* L.

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Abstract

This research was carried out in a private filed at Al–Abassia district in the province of Najaf during the 2018 spring and autumn growing seasons. It aimed to study the response of three varieties of cowpea Ramshorn, Riyadh and Black eye to three types of fertilizers including Phosphorus fertilizer (P_2O_5 28 %) at 160Kg.hectare^{-1}, Bio fertilizer using *Bacillus subtilis* at 10ml.plant^{-1} and organic commercial fertilizer GLOBALGA contains 7 % phosphorus at rate of 4ml.liter^{-1} compared to unfertilized control plants. The experiment was factorial split–plot according to Randomized Complete Block Design (RCBD) with three replications for each treatment. Duncan's multiples range test was used to compare means difference (*P*d≤0.05). The results showed that as the Riyadh was significantly increased plant height to 94.74 and 94.67 cm while the Black eye variety effect was significantly increased the dry matter to 69.78 and 64.08 gm.plant^{-1} and chlorophyll content in the leaves to 34.04 and 52.78 mg.100 gm^{-1} fresh weight for both seasons respectively. the organic fertilizer was significantly increased plant height to 89.40 and 69.80 cm while the Bio – fertilizer markedly increased dry matter to 68.38 and 60.08 gm. plant^{-1}, chlorophyll content to 35.43 and 55.76 mg.100 gm fresh weight^{-1} for both seasons respectively. The results showed there were non significantly between varieties in percentage of nitrogen in the leaves while the Black eye variety was significantly increased in phosphorus 0.482 and 0.692 % and potassium 0.823 and 1.203 %. the organic fertilizer was significantly increased percentage of nitrogen in the leaves to 3.39 and 3.68 % and there was no significant difference between the Bio – fertilizer where recoded 3.31 and 3.72 % the Bio – fertilizer was significantly increased the percentage of phosphorus to 0.548 and 0.725 % and potassium 0.929 and 1.310 % for both seasons respectively.

Key words : Fertilization, vegetative growth, cowpea.

Introduction

Cowpea *Vigna unguiculata* L**.** in the legume family plants is believed to originated in the Central Africa from which its cultivation was widely spread the semitropical and temperate regions. It is like other legume crops plants, is known to tolerate hot and dry environmental conditions and helps in improving soil natural properties through stabilizing atmospheric nitrogen in the soil (Pradeep & Elamathi, 2007). Cowpea is grown for their green pods and dry seeds as well as can be used as cover crop. and is nutrient – rich crop each 100 gm of green pods contain 86% water, 3.3% protein, 9.5 carbohydrates and 44 calories (Amujoyegbe & Alofe, 2003).

Phosphorus is a key element in plant nutrition. It contributes in the plant growth processes, cell formation and division and seed formation. Phosphorus comes in third place in terms of the amount the plant needs after nitrogen and potassium for most crops. Therefore, its readiness in the soil during the stages of plant growth, especially at the stage of root formation and growing, branching and flowering is necessary for good crop productivity (Mfilingel & others, 2014). Phosphorus is involved in many compounds and biological interactions including phospholipids synthesis, which play an important role in the construction of cell protoplasm, and in the construction and synthesis of nucleotides, which are the building blocks of nucleic acids and the transfer of genetic traits through DNA and RNA as well as the formation of energy compounds such as ADP and ATP (Verma, 2007). Studies have also shown that phosphorus helps Rhizobium-fixing bacteria in root nodes formation, especially in the composition of phospholipids for these

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microorganisms. Other studies have reported that phosphorus deficiency negatively affected the processing of nitrogen fixation process by the Rhizobium-fixing bacteria) Weisany *et al.,* 2013).

The use of organic fertilizers is an important way to avoid problems resulting from the use of chemical fertilizers, which work to produce negative effects, including pollution of groundwater with the effects of those fertilizers, as well as increasing the content of agricultural products of some harmful compounds such as nitrates and causing health problems for humans and animals Organic fertilizers are environmentally safe and economically less expensive (Oad and Agha, 2004).

Bio-fertilization is one of the factors that affect the growth of plants, especially vegetable plants Adding them improves the characteristics of vegetative growth and increase it by providing the plant with nutrients and increase the readiness of the plant and its entry into the construction of organic compounds or improve the course of vital activities within the plant, which reflects positively on growth indicators (Karthikeyan *et al.,* 2009), For the purpose of creating suitable conditions for changes in the soil biological content and surrounding the region of the root hairs Rhizosphere has been used biofertilizers, through which the seeds of plants or soil inoculated microorganisms, including the biofertilizer Bacillus subitilus and Bacillus polymax, where such biofertilizers increase the readiness of the nutritional content Soil, which is reflected in increasing soil fertility and improving yield, which in turn work to activate the work of enzymes in plant cells and speed in the metabolism of plant cells and help in the synthesis of proteins and carbohydrates (Taiz & Zeiger-2006).

Cowpea varieties vary widely in color, shape and size (Abiodu Adelec, 2011), The seed cover is either soft or curly and has different colors, including white, cream, orange, red, brown and black. Or another color (Encyclopaedia, 2014), Although there are many cowpea varieties, the development of new varieties continues to improve yields and yield quality (Chinma & others 2008).

The experiment was carried out during the agricultural season 2018 - 2019, for the spring and autumn seasons in the Abbasiya / Najaf province. The land was divided into three equal parts and each sector was divided into 12 experimental units and a total of 36 experimental units. The dimensions of the experimental unit were 180 cm * 50 cm and left a distance (75-80) cm between each experimental unit and the other to prevent overlap between the plants. One experimental unit contained 10 plants with a distance of 30 cm between one plant and another. The seeds were planted directly in the field on 15/3/2018 for spring season and 15/8/2018 for autumn season. The plants were watered directly by water logging. With repeated irrigation depending on the environmental conditions and the need of the plant. The experimental factor was two cowpea varieties (Ramshorn, Riyadh and Black eye) and different sources of phosphate fertilization, conventional chemical fertilization (P_2O_5) by 28% and at the level of 160 kg. Plant 1. Fertilizer 4 ml. Plant 1 - using liquid commercial fertilizer concentrated GLOBALGA, which contains 7% organic phosphorus. While comparative plants were left without fertilization. The experiment was designed with the design of complete random segments, splitting board system and three replicates.

Measurements and data analysis

The spring trail experiment was ended in 3/7/2018) while the autumn one ended in where data were recorded for the vegetative growth parameters including plant height (cm), shoot dry weight (g), leaf content of total chlorophyll (mg. $100g^{-1}$FW) and plant content of nutrients including leaf content (%) of nitrogen, phosphorus and potassium. Data were statistically analyzed and analysis of variance was performed using the GenStat (12th Edition) statistical computing system. Differences among means were compared based on Duncan's multiple range tests at a 5% probability level ($P \leq 0.05$).

Table 1: Chemical and physical properties of the soil.

Properties	Unit	Value
Clay	%	52
Silt	%	240
Sand	%	708
Soil texture		Mix Sand
EC	$Ds.m^{-1}$	1.55
PH		7.4
N	$mg.kg^{-1}$	3.808
P	$mg.kg^{-1}$	6.87
K	$mg.kg^{-1}$	14.6
Organic carbon	%	0.2

Results and Discussion

Plant height (cm)

The results showed table 2 that the highest plant height was Riyadh 94.74 and 94.67 cm for the two loops respectively, with significant differences from the Black Eye cultivars (73.07 cm) for the spring and Ramshorn A (44.77 cm) for the fall season. As for the effect of phosphorus sources, organic fertilization was the most effective in increasing the height of the plant, but did not differ from the treatment of chemical fertilization in the

Table 2: Effect of potassium fertilization of different fertilizer types on plant height, shoot dry weight and leaf content of total chlorophyll in three cowpea cultivars.

		Plant height (cm)				Dry matter weight (g)				Leaf content of total chlorophyll			
		Fertilization type											
		Control	Che.	Bio.	Org.	Control	Che.	Bio.	Org.	Control	Che.	Bio.	Org.
SPRING	Ramshorn	62.52e	74.14cde	89.51Bc	76.24bcde	44.27d	63.14bcd	62.43bcd	57.71bcd	20.52c	31.26abc	30.94abc	28.24abc
	Riyadh	65.32e	116.52a	87.31Bc	109.81A	51.31cd	56.74bcd	59.54bcd	73.52Ab	21.32c	22.84bc	39.78a	27.22bc
	Black eye	68.74de	73.47cde	67.93De	82.17Bcd	59.04bcd	67.82abc	83.19a	69.08abc	28.46abc	39.31a	35.58ab	32.81abc
	Average	65.52c	88.04a	81.58B	89.40A	51.54b	62.56ab	68.38a	66.77A	23.43c	31.13ab	35.43a	29.4b
AUTOMN	Ramshorn	39.28f	48.63e	47.67E	43.53E	44.19d	66.51abc	58.86abc	50.13Cd	42.93cd	53.96b	51.48ab	54.53b
	Riyadh	62.34c	109.12a	94.84B	112.41A	44.88d	52.53cd	53.30cd	50.68Cd	38.16d	47.49c	54.25b	51.17ab
	Black eye	46.92e	52.33cd	53.52Cd	53.47Cd	55.54bcd	66.33ab	68.07a	66.38Ab	44.41c	52.92ab	61.57a	52.23ab
	Average	49.51c	70.02a	65.34Ab	69.80A	48.20b	61.79a	60.07a	55.73A	41.83b	51.45ab	55.76a	52.64ab

Values are means of three replicates (planting lines). Means that have same letter(s) within a season or within the average row are not significantly different according to Duncan's multiple range tests ($P \leq 0.05$). treatments are conventional chemical fertilizer (Che.), *Bacillus subtilis* Biofertilizer (Bio.) and commercial seaweed concentrate as organic fertilizer (Org.) in addition to non-fertilized plants (control).

Table 3: Effect of potassium fertilization of different fertilizer types on leaf content (%) of nitrogen, phosphorus and potassium in three cowpea cultivars.

		% Leaf content of nitrogen				% Leaf content of phosphorus				% Leaf content of potassium			
		Fertilization type											
		Control	Che.	Bio.	Org.	Control	Che.	Bio.	Org.	Control	Che.	Bio.	Org.
SPRING	Ramshorn	2.68c	3.25abc	3.32Ab	3.20abc	0.211d	0.357cd	0.595ab	0.494abc	0.474d	0.981A	0.895ab	0.786abc
	Riyadh	2.87bc	2.95abc	3.16Abc	3.51a	0.281cd	0.280cd	0.408bcd	0.354Cd	0.595cd	0.640bcd	0.895ab	0.776abc
	Black eye	3.06abc	3.18abc	3.46Ab	3.46ab	0.235d	0.469abcd	0.642a	0.585Ab	0.635bcd	0.947a	0.999a	0.710abcd
	Average	2.87b	3.12ab	3.31A	3.39a	0.242c	0.368ab	0.548a	0.477B	0.568c	0.856ab	0.929a	0.757b
AUTOMN	Ramshorn	2.33d	2.69cd	3.68Ab	3.81a	0.570cd	0.685bc	0.715abc	0.775Ab	0.967bc	1.202ab	1.204ab	0.899bc
	Riyadh	2.04e	3.04c	3.64Ab	3.34bc	0.501d	0.768ab	0.645bcd	0.602Cd	1.050bc	0.908bc	1.216ab	1.111bc
	Black eye	2.24cd	3.61ab	3.76Ab	3.90a	0.582cd	0.681bc	0.816a	0.691abcd	0.814c	1.029bc	1.510a	1.458a
	Average	2.20b	3.11ab	3.69A	3.68a	0.551c	0.711a	0.725a	0.689B	0.944c	1.046bc	1.310a	1.156ab

Values are means of three replicates (planting lines). Means that have same letter(s) within a season or within the average row are not significantly different according to Duncan's multiple range tests (*P*d”0.05). treatments are conventional chemical fertilizer (Che.), *Bacillus subtilis* Biofertilizer (Bio.) and commercial seaweed concentrate as organic fertilizer (Org.) in addition to non-fertilized plants (control).

spring. While the fertilizer was the most effective in autumn season and did not differ significantly from organic fertilization compared to the control treatment, which led to the lowest plant height for both growing seasons with a significant difference from fertilization treatments. Generally, the highest value of plant height was recorded in the interaction between Riyadh variety and chemical fertilization 116.52 or organic fertilization 109.81 cm for the spring and 109.12 and 112.41 cm in the autumn season compared to the lowest plant height 62.52 and 39.28 cm in the overlap between Ramshorn and non-fertilization for both seasons respectively.

Dry matter (gm.plant^{-1})

As for the dry weight of the total vegetative, it is noticed from the results table 2 that the highest dry weight was in the black eye for growth seasons, while the lowest varieties in the proportion of dry matter were Ramshorn for spring and Riyadh for autumn. As for the effect of fertilization, the bio and organic fertilizer of the spring season and the bio fertilizer for the autumn season showed the highest percentage of dry matter, slightly different from other fertilization treatments and significant difference from the treatment control or non-fertilization for both seasons. The highest dry weight was 83.19 and 68.07 g compared to the interaction of Ramshorn and untreated control with the lowest values of 44.27 and 44.19 g for both seasons, respectively.

Leaf content of chlorophyll mg.100 gm^{-1} fresh weight

When comparing the items with respect to leaf content of chlorophyll, the results table 2 showed that the highest percentage of chlorophyll was in the black eye variety regardless of treatment and for both seasons with significant difference from chlorophyll content of Ramshorn for spring and Riyadh for autumn. As for the fertilization treatments, bio-fertilization showed the highest content of chlorophyll for both seasons and a significant difference from the treatment of non-fertilization.

The interaction between Riyadh and the addition of biofertilization resulted in the highest percentage of chlorophyll content for the spring season, which did not differ significantly ($P \leq 0.05$) from the treatment of Black Eye with chemical fertilization. As for the autumn seasons, the interaction of Black Eye with bio fertilization recorded the highest values and significant differences compared to the treatment of Riyadh with no fertilization.

Leaf content of total nitrogen

As for the nitrogen content of the leaves, table 3 showed that the varieties did not differ for the spring semester, whereas the varieties differed in the autumn season when the black eye recorded the highest content of the nitrogen with a slight difference from Riyadh and Ramshorn. The results of the same table indicated the superiority of organic and biofertilization in increasing the nitrogen content in the leaves compared to the treatment of chemical fertilization and control for both seasons respectively. The interaction of Riyadh with organic fertilization was the highest nitrogen for spring leaves, whereas the highest fall was in black eye and organic fertilizer application.

Leaf content (%) of phosphorus

The results in table 3 show that the percentage of leaf phosphorus content was significantly higher in Black eye and Ramshorn compared to Riyadh cultivar which recorded the lowest phosphorus content for both seasons respectively. The same results indicate that plants treated with biofertilization showed the highest increase of phosphorus content in the leaves for both seasons compared to other fertilization treatments and non-fertilized plants. Generally, the highest phosphorus content in the leaves was recorded in the treatment of interaction between Black eye with bio-fertilization of the spring semester 0.642 and autumn by 0.816% compared to Ramshorn cultivar with control treatment of 0.211% for spring semester and Riyadh for the same treatment 0.501% for autumn.

Leaf content (%) of potassium

Similarly, the cultivars did not differ in the leaf content of potassium for the spring season, whereas the Black Eye recorded the highest potassium content compared to Ramshorn for autumn season (Table 3). Bio-fertilization also resulted in the highest increase in leaf potassium for both seasons compared to the control treatment. The effect of the interaction between the black eye and the bio-fertilization was evident in raising potassium levels in the leaves with high significant differences from the interaction between Ramshorn and non-fertilized for the spring and non-fertilized black eye for autumn.

Findings of this study showed that there were significant differences among the three cowpea cultivars in vegetative growth characters properties and leaf content of nutrients. This may be due to the effect of plant variety resulting from genetic variation between varieties. Or the reason may be due to the suitability of environmental conditions for one plant variety, but not to the other. This resulted in a variation in the efficiency of photosynthesis which positively affected the increase of vegetative growth (Madukwe *et al.,* 2018; Mfeca *et al.,* 2019).

It is clear from the results that vegetative growth indicators differed due to different source of phosphate fertilization,

It was noted that the addition of bio-fertilization had a significant effect in increasing most of the vegetative growth characteristics including leafy area, dry weight of the total vegetation, leaf content of chlorophyll, number of bacterial nodes and number of branches. This is due to the ability of these microorganisms to convert the element phosphorus from the image fixed in the soil to its image ready for absorption by the plant (Schister *et al.,* 2004).

Increased plant content of this element is an indicator of plant health because phosphorus is a necessary ingredient in plant nutrition during different growth stages (Awasthi *et al.,* 2011).

The plant needed phosphorus because it is an essential element in the processes of metabolism and cell division. This element is vital in the formation of ATP, which transports energy and thus contributes to increase the efficiency of photosynthesis and increase the size and number of cells by stimulating the increase of the total vegetative density and as a result the increase of dry weight in general (Ndakidemi and Dokora, 2007)

The increased readiness of soil elements is due to the ability of *Bacillus subtilis* to secrete stimulants into the growth medium, including IAA, cytokinin and gibberellin GA3, which promote increased cell division and thus increase vegetative and root growth of the plant, thus positively increasing Absorption of nutrients (Jungwook *et al.,* 2009).

These bacteria also help release nutrients from clay minerals as a result of the biological activity of these microorganisms.

This leads to an increase in the formation of organic acids in the zone of radical growth and reduce the degree of soil PH, which helps to release more nutrients, including potassium. As well as the role of bacteria in the production of Siderophores, which is a substance chelating nutrients, prevent elements from adsorption to soil minutes or washed outside the root growth area and thus increase the readiness of the plant Metin (*et al*., 2010).

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