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Integrated Nutrient Management of Organic and Bio-Fertilizer to Enhance Maize Production

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Abstract

Integrated nutrient management (INM) is the concept of using a combination of organic, inorganic, and biological amendments to increase nitrogen use efficiency (NUE) and reduce nutrient loss by synchronizing crop demand with nutrient availability in soil. In order to produce more food with limited space, farmers utilize several techniques. One of the best techniques is application of different types of organic and biofertilizers in soil in integrated nutrient management system and consequently maintain the soil nutrients level. It allows plant to grow, flourish, and keep the environment save. Importance of maize (*Zea mays* L.) crop is justified by its nutritious content especially because of the presence of high protein, minerals, vitamins and other energetic nutrients. In Egypt, maize production is insufficient, so various strategies have been developed to improve its production. In order to study the promoting effect of organic and biofertilizer on growth and yield of maize plant, a field experiment was conducted in Wadi El-Rayan, Fayoum Governorate, Egypt, during the two successive seasons of 2014 and 2015 to study the impact of organic or/and bio-fertilizer on growth, yield and its components and some chemical contents of two maize cultivars. The present study indicate that organic or/and bio-fertilizer had a positive effect on growth parameters. Yield and its components characters i.e. plant height (cm), number of rows per ear, length and diameter of ear, grain and straw yield per plant (g), seed index, grain, straw and biological yields (ton/fad.) of maize were also enhanced with organic or/and bio-fertilizer application. There were significant differences between two maize cultivars in growth parameters, yield and its components expect harvest index. The highest values of number of rows per ear (23.37**)**, length of ear (22.517 cm), diameter of ear (6.36cm), grain yield per plant (151.67g) and straw yield per plant (262.33g) were recorded in High tech-2031 cultivar fertilized under 10 ton/fad. pigeon manure + foliar application of yeast bread. High tech-2031 cultivar fertilized with 10 ton/fad. pigeon manure + foliar application of yeast bread produced the highest value of carbohydrate and protein % in the grains.

Keywords: Maize, growth, yield, cultivars, organic or/ and bio-fertilizer

1 Introduction

Maize is called “King of cereals” because of its productivity potential compared to any other cereal crop. Being an exhaustive crop, it has very high nutrient requirement and its productivity is closely depends on nutrient management system. Maize (*Zea mays* L.) is the world’s widely grown highland cereal and primary staple food crop in many developing countries. Maize occupies third place following wheat and rice in Egypt and world production [1]. It widely grown in tropics and sub tropics of Africa, because of the increasing demand for food and livestock feed.

Increasing Maize yield per unit area can be achieved by breeding high yielding cultivars. Maize cultivars production is one of the most important factors which play a major role in increases maize production. Maize cultivars differed in vegetative growth. Grain, straw and biological yields and its components were significantly owing to varietals differences [2].

Majorly poor management of fertilizer has key role to play in obtaining low yield productivity, so in order to achieve optimum crop productivity management of nutrients through judicious application of organic sources and bio-fertilizers are required [3]. Egypt suffers from the continued high rates of population growth year after the other, leading to a rapid deterioration in the soil because ofslipstreamed plantings to face the needs of populations therefore considered application of organic fertilizer is the best ways to sustainable agriculture and protecting contamination of the environmental. Researchers have shown that the use of organic manure improves the chemical and physical properties of the soil [4], Soils rarely have sufficient nutrient for crops to reach their potential yield. Applying organic fertilizers without prior knowledge of their properties may cause yield decline under low application or pollute the environment with excessive application [5]. Thereby increasing the growth and yield of maize [6, 7]. Paulina (2013) [8] also indicated that addition of organic fertilizer application to improve some physical soil properties (such as bulk density

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(BD), soil texture, infiltration rate (IF) and aggregate stability (AS) as well as the soil organic content in the soil (OC) and hence to increase maize yield in western Kenya. Recently, Soro *et al.,* (2015) [6] revealed the positive impact of the manure on the growth and development of corn crops.

Addition of bio-fertilizer is very important to reduce the use of mineral fertilizers, decrease input use, increase net profit and minimize contaminates environments. Using of yeast as a bio-fertilizer in agriculture has taken a considerable attention because of their bioactivity and safety for human and the environment [9]. It can be added to the soil or as foliar application to crops [10] as they contain many nutrients, some of trace elements such as calcium, cobalt, iron and a good source of the B-complex vitamins such as B1, B2, B6 and B12 as well as its role in producing important substances like growth regulators such as gibberellins, auxins [11]. Many researches on various crops proved that yeast treatment has beneficial role in improving growth and yield of crops Dawood *et al.,* (2013) [12] on Soybean, Marzauk *et al.,* (2014) [13] on Broad bean and Ahmed *et al.,* (2015) [14] on Fenugreek. Recently, (Hellal *et al*., 2014) [15] stated that, foliar feeding with Effective Microorganisms in combination with organic manure has become an argument procedure to improve nutrient utilization through improving root growth and increasing nutrient uptake and minimize environmental pollution through reducing the amount of mineral fertilizers added to soil.

The objective of the current work is to study the impact of organic or/ and bio-fertilizer on growth, yield and its components and some chemical contents of two maize cultivars.

2 Materials & Methods

A field experiment was conducted in the Wadi El-Rayan, Fayoum Governorate, Egypt, during the two successive seasons of 2014 and 2015 to study the impact of organic and bio-fertilizer on growth, yield andits components and some chemical contents of two maize cultivars. Physical and chemical properties of soil (0-30 depth) in the experimental site were as follows: sand 52.5%, silt 20%, clay 27.5%, pH 8.02, organic matter 0.84 %,$CaCO_3$, 20.9%, EC 2.9 mmhos/$cm^3$and soluble N 74 ppm according to the method described by Chapman and Pratt (1961) [16]. The experimental design was split plots design with four replicates, two maize cultivars {High tech-2031(V1) and Weitaniy-11(V2)} were assigned to the main plots and five treatments of organic or/and bio-fertilizer plus control (without fertilizer) were randomly distributed in the sub plots. Maize grains were sown on May 25th and 28thin the first and second seasons, respectively. Nitrogen fertilizer was applied in the form of ammonium nitrate (33.5 % N) at the rate of 90N kg/ fad in two equal doses, before 1st and 2nd irrigation, phosphorus and potassium fertilizer were applied at the recommended rate.

Organic fertilizer treatments as the form of the pigeon manure (P.M) had the following chemical composition:- EC (Dsm^{-1}) {7.65}, Organic matter % {69.8}, pH {6.12}, Total C% {33.6},Total N% {4.31}, C/N ratio {7.80} Total P%{0.97},K% {0.98},Fe (µg/g) {240.3}, Mn (µg/g) {50.8}, Zn (µg/g) {92.60},Cu (µg/g) {7.65}.

Yeast Bread(YB) extract was prepared from brewer's yeast (*saccharomyces cerevisiae*) dissolved in water followed by adding sugar at a ratio of 1: 1 and kept 24 hours in a warm place for reproduction. Foliar fertilizer treatments were sprayed on plant foliage twice during maize plant growth period at 35 and 55days after sowing. The normal agronomic practices of growing maize were practiced till harvest as recommended in this district.

Two vegetative samples of ten plants were taken at random from the middle area of each plot to measure plant height (cm), total dry weight per plant (g), number of ears per plant, leaf area/plant (dm^2) and leaf area index (LAI) at 65 and 95 days after sowing. At harvest time, a random sample of ten plants were taken from each plot to determine plant height (cm), number of rows per ear, length and diameter of ear(cm), grain and straw yield per plant (g) and seed index. Grain, straw and biological yields (ton/fad.) as well as harvest index were determined for the whole plot. Protein and carbohydrate percentages in grain were also determined by infratec1241 Grain Analyzer. All data were subjected to statistical analysis according to procedure outlined by Snedecor and Cochran (1990) [17]. Treatments means were compared by L.S.D test.

3 Results & Discussion

3.1 Effect on growth

The growth parameters as affected by cultivars, organic or / and bio-fertilizer and interaction between them are presented in Table (1). However, the different between both cultivars on growth parameters i.e. plant height (cm), total plant dry weight (g), number of ears per plant, leaf area/plant (dm^2) and leaf area index (LAI) at 65 and 95 days after sowing were significantly.

Regardless cultivars**,** results in Table 1 revealed also that organic or / and bio fertilizer significantly increased all growth parameters. Moreover, foliar application of yeast bread recorded higher values for all growth parameters compared with unsprayed plant (control).

The increase of growth parameters of maize plant fertilized at 10 ton/fad. pigeon manure was more pronounced than plants sprayed by foliar yeast bread treatment. Highest values of plant height (cm), total plant dry weight (g), number of ears per plant, leaf area/plant (dm^2) and leaf area index (LAI) at 65 and 95 days after sowing were obtained by fertilized at10 ton/fad. pigeon manure + foliar of yeast bread.

The interaction between cultivars and organic or/and bio-fertilizer caused a significant effect for all growth parameters at 65 and 95 days after sowing (Table 1). High tech-2031 cultivar fertilized with 10 ton/fad. pigeon manure + foliar of yeast bread recorded the highest values of all growth parameters at 65 and 95 days after sowing, while the lowest values of these parameters were recorded in unfertilized plants of cultivar Weitaniy-11 cultivars.

3.2 Effect on yield and its components:

There were significant differences between the two maize cultivars in yield and its components expect harvest index (Table, 2). High tech-2031 cultivar significantly exceeded Weitaniy-11cultivar in yield and its components. The productivity of components such as, plant height (cm), number of rows per ear, length and diameter of ear, grain and straw yield per plant (g) and seed index affected by the organic or / and bio fertilizer in Table (2).

Table 1: Effect of cultivars, organic or / and bio-fertilizer and interactions on growth parameters

Treatments		Plant height (cm)		Total dry weight per plant		Number of Ears per plant	Leaf area (dm^2)		LAI	
		65 days	95 days	65 days	95 days	95 days	65days	95 days	65 days	95 days
High tech-2031(V1)		273.68	293.19	313.83	343.44	1.33	46.78	56.18	2.34	2.81
Weitaniy-11(V2)		268.64	289.24	304.98	323.98	1.21	43.68	50.20	2.21	2.51
L.D.S at 5% level		0.90	3.70	1.41	0.96	0.01	0.59	0.15	0.06	0.01
Control		259.89	281.05	289.01	304.02	1.17	38.96	47.85	1.95	2.39
5 ton (P.M)		267.13	286.64	296.08	312.13	1.22	42.96	52.50	2.15	2.63
10ton (P.M)		276.30	291.52	307.47	329.73	1.28	47.41	55.50	2.37	2.78
(Y.B)		265.75	288.69	306.02	329.61	1.24	42.95	50.05	2.13	2.50
5 ton (P.M) +(Y.B)		275.88	298.04	321.33	345.59	1.31	47.62	54.22	2.47	2.71
10 ton (P.M) +(Y.B)		281.98	301.35	336.53	381.17	1.39	51.50	59.00	2.58	2.95
L.D.S at 5% level		2.58	3.54	1.30	1.54	0.01	0.96	0.73	0.09	0.04
Interactions										
V1	Control	265.18	284.50	294.83	309.20	1.21	40.63	50.51	2.03	2.53
	5 ton (P.M)	268.44	288.85	302.28	322.25	1.27	45.24	55.67	2.26	2.78
	10ton (P.M)	280.53	293.53	314.93	346.80	1.34	49.38	59.00	2.47	2.95
	(Y.B)	266.89	290.51	303.21	331.89	1.30	43.86	51.77	2.16	2.59
	5 ton /f(P.M) +(Y.B)	276.56	299.42	325.66	355.18	1.36	48.91	58.10	2.45	2.91
	10 ton (P.M) +(Y.B)	284.49	302.36	342.07	395.33	1.47	52.67	62.00	2.64	3.10
V2	Control	254.61	277.61	283.18	298.85	1.12	37.28	45.19	1.86	2.26
	5 ton (P.M)	265.83	284.42	289.87	302.00	1.17	40.67	49.33	2.03	2.47
	10ton (P.M)	272.08	289.52	300.00	312.67	1.22	45.44	52.00	2.27	2.60
	(Y.B)	264.62	286.88	308.83	327.33	1.18	42.04	48.33	2.10	2.42
	5 ton (P.M) +(Y.B)	275.21	296.67	317.00	336.00	1.26	46.33	50.33	2.48	2.52
	10 ton (P.M) +(Y.B)	279.47	300.33	331.00	367.00	1.30	50.33	56.00	2.52	2.80
L.D.S at 5% level		3.64	5.00	1.83	2.18	0.01	1.36	1.03	0.13	0.05

Table 2: Effect of cultivars, organic or / and bio fertilizer and interactions on yield and its components.

Treatments		Plant height (cm)	Number row of /ear	Ear Length (cm)	Ear Diameter (cm)	Grain yield Per plant	Straw yield Per plant	Seed index	Grain yield Per fad.	Straw yield Per fad.	Biological yield Per fad.	Harvest index
High tech-2031(V1)		308.56	23.28	22.334	6.26	143.08	252.11	27.133	3.15	5.55	8.70	36.19
Weitaniy-11(V2)		303.39	22.48	22.171	6.14	140.50	246.28	26.858	3.09	5.43	8.52	36.26
L.D.S at 5% level		4.20	0.01	0.004	0.01	1.09	0.74	0.003	0.03	0.03	0.06	NS
Control		290.06	22.65	22.063	6.07	134.35	237.83	26.857	2.96	5.26	8.22	35.99
5 Ton (P.M)		297.94	22.80	22.147	6.13	138.17	244.83	26.940	3.04	5.39	8.43	36.08
10Ton (P.M)		306.95	22.90	22.253	6.22	141.05	251.17	27.032	3.11	5.54	8.64	35.92
(Y.B)		305.63	22.89	22.270	6.19	141.17	247.67	26.942	3.11	5.45	8.55	36.30
5 Ton (P.M) +(Y.B)		314.18	22.98	22.367	6.26	145.50	253.83	27.058	3.20	5.60	8.80	36.38
10 Ton (P.M) +(Y.B)		321.10	23.05	22.415	6.33	150.50	259.83	27.115	3.31	5.72	9.03	36.68
L.D.S at 5% level		3.23	0.01	0.016	0.01	0.75	1.29	0.009	0.02	0.02	0.03	0.16
Interactions												
V1	Control	298.42	23.14	22.127	6.14	136.07	241.67	27.000	3.00	5.32	8.32	36.07
	5 ton (P.M)	302.73	23.24	22.233	6.21	139.33	248.00	27.040	3.07	5.46	8.52	35.98
	10ton (P.M)	313.18	23.35	22.350	6.29	142.44	254.67	27.147	3.14	5.60	8.74	35.89
	(Y.B)	303.74	23.27	22.330	6.25	142.00	250.00	27.070	3.12	5.50	8.62	36.22
	5 ton /f(P.M) +(Y.B)	312.78	23.32	22.447	6.31	147.00	256.00	27.230	3.23	5.66	8.89	36.36
	10 ton (P.M) +(Y.B)	320.54	23.37	22.517	6.36	151.67	262.33	27.310	3.34	5.77	9.11	36.63
V2	Control	281.69	22.16	22.000	6.00	132.64	234.00	26.713	2.92	5.21	8.12	35.91
	5 ton (P.M)	293.15	22.35	22.060	6.05	137.00	241.67	26.840	3.01	5.32	8.33	36.17
	10ton (P.M)	300.72	22.46	22.157	6.16	139.67	247.67	26.917	3.07	5.47	8.55	35.96
	(Y.B)	307.53	22.51	22.210	6.12	140.33	245.33	26.813	3.09	5.40	8.48	36.39
	5 ton (P.M) +(Y.B)	315.58	22.64	22.287	6.22	144.00	251.67	26.887	3.17	5.54	8.71	36.41
	10 ton (P.M) +(Y.B)	321.67	22.74	22.313	6.29	149.33	257.33	26.920	3.29	5.66	8.95	36.74
L.D.S at 5% level		4.56	0.02	0.022	0.02	1.07	1.82	0.013	0.02	0.03	0.04	0.22

The higher percent increases in cumulative grain yield per fad was 10 ton /fad pigeon manure + foliar of yeast bread (11.37), while the lower percent increases in grain yield was 5 t/fad pigeon manure (2.76) compared with control treatment. Biological yield per fad was increased under fertilizedat10 ton /fadpigeon manure + foliar of yeast bread, because there were significant increasing in plant height and total plant dry weight at 65 and 95 days after sowing. With respect to the interactions between cultivars and organic or/and bio-fertilizer on maize yield and its components (Table 2). All interactionhad distinctly influenced yield components of maize. The highest values of number of rows per ear (23.37**)**, length of ear (22.517 cm), diameter of ear (6.36 cm), grain yield per plant (151.67 g) and straw yield per plant (262.33 g) were recorded in High tech-2031 cultivar fertilized at 10 ton/fad. pigeon manure + foliar of yeast bread.

3.3 Effect on carbohydrate and protein % in the grains

Results in Figure (1, 2) indicated that maize cultivars exhibited significant results for carbohydrate and protein % in the grains. High tech-2031 cultivar had the superior in carbohydrate and protein % in the grains. Higher content of carbohydrate and protein were recorded at 10 ton/fad. pigeon manure + foliar of yeast bread (Figures 1 and 2).

Concerning the interaction effects between cultivars and fertilizer treatments on carbohydrate and protein % in the grains, data in Fig 3, 4 indicated that High tech-2031 cultivar fertilized at 10 ton/fad. pigeon manure + foliar of yeast bread gave the highest value of carbohydrate and protein % in the grains.

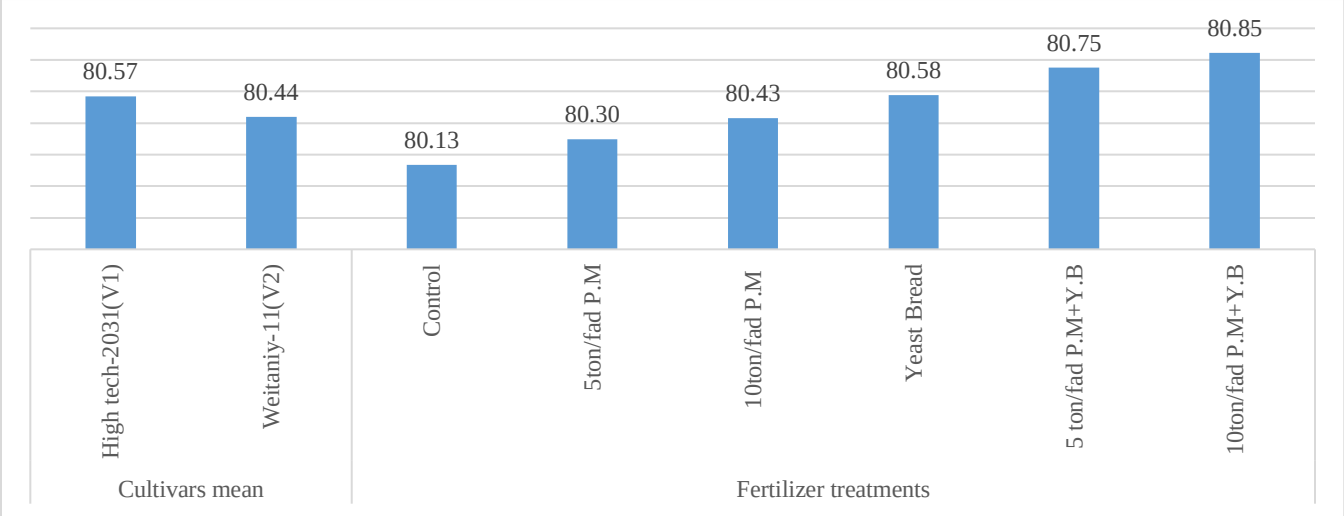

Figure 1: Effect of cultivars and treatments fertilizer on carbohydrate% {LSD 5% V (0.012), F (0.010)}

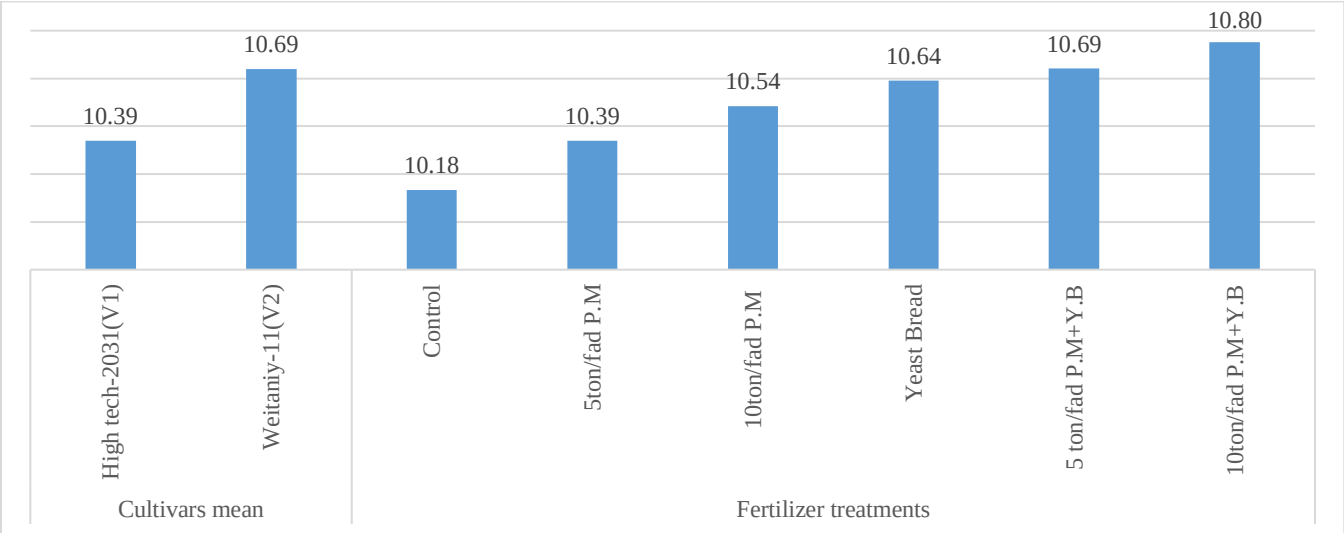

Figure 2: Effect of cultivars and treatments fertilizer on protein % {LSD 5% V (0.012), F (0.009)}

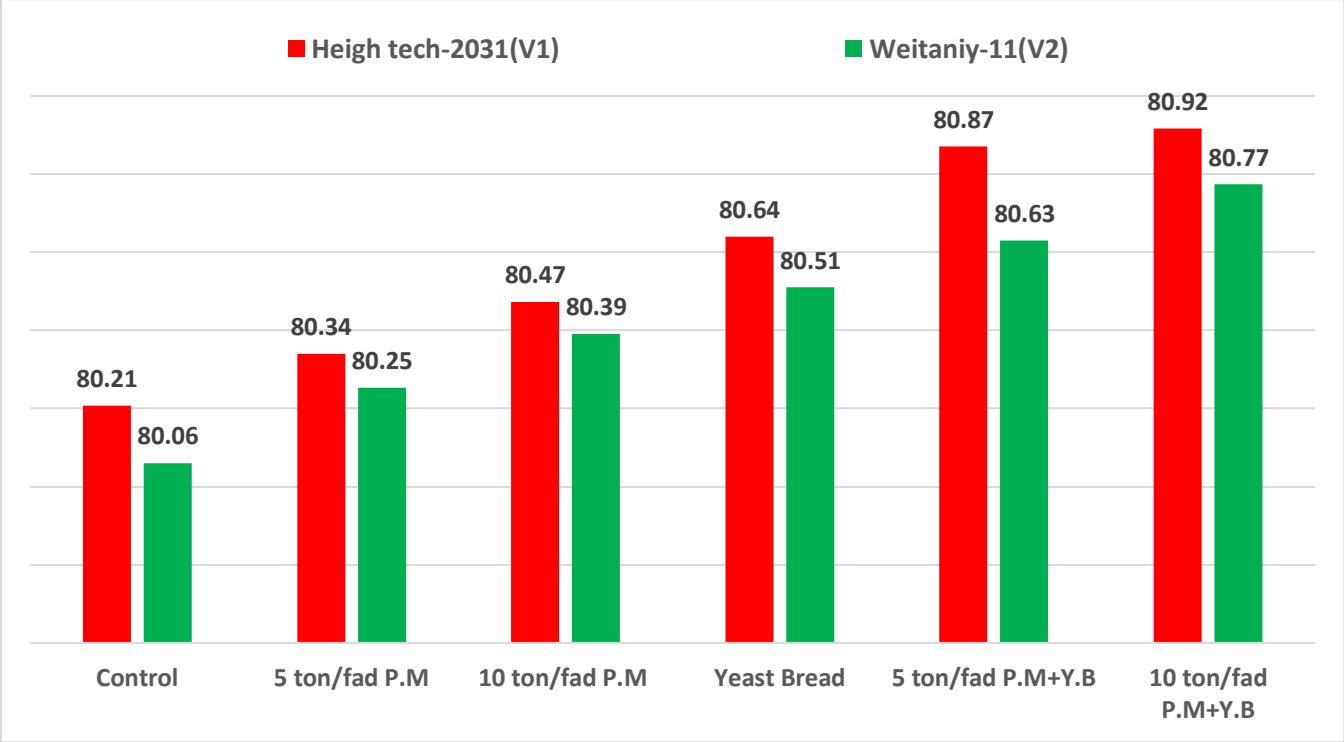

Figure 3: Effect of interaction between cultivars andtreatments fertilizer on carbohydrate% (LSD 5% 0.015)

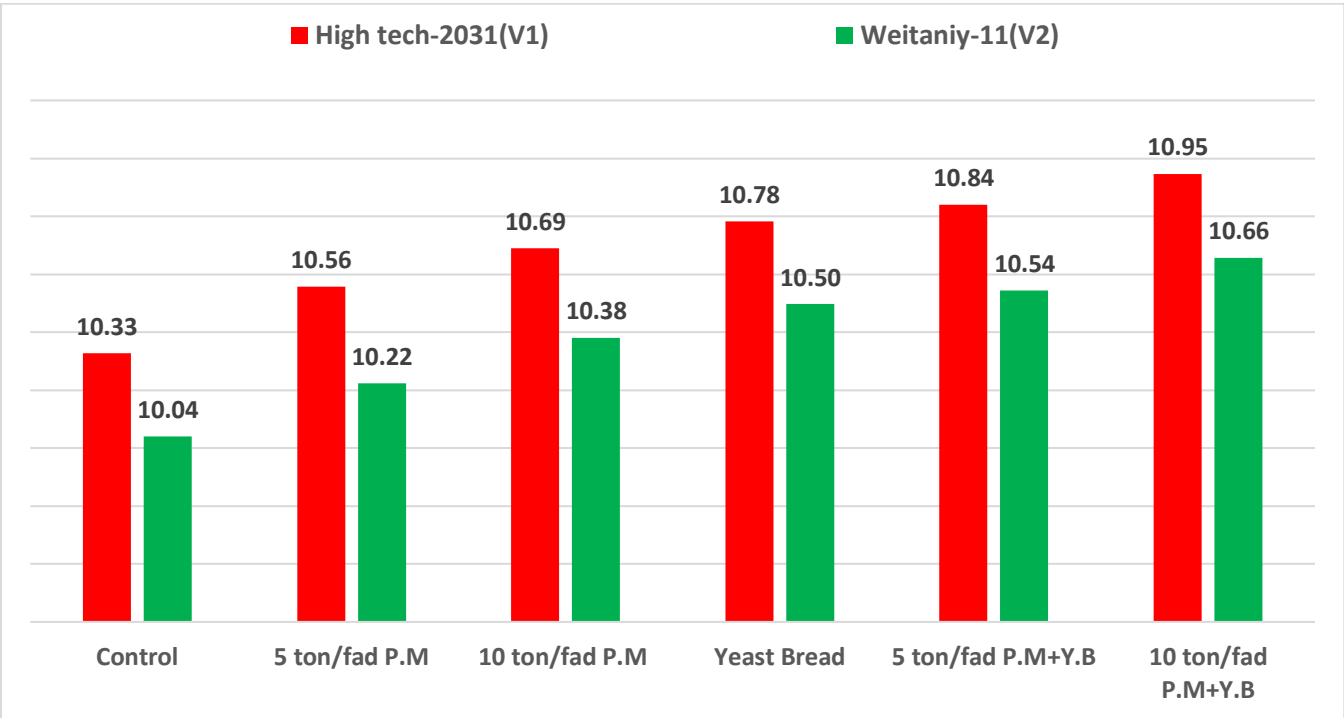

Figure 4: Effect of interaction between cultivar, organic or / and bio fertilizer on protein % (LSD 5% 0.012)

The differences of growth parameters between the two cultivars may be due to the genetic differences between them. Similar results were obtained by (Hassan *et al*., 2008, Naserirad *et al.,* 2011 Dahmardeh, 2012 and Soro *et al*., 2015) [18, 3, 4, 6] who found that the differences among cultivars were significant.

Such enhancement effect of organic or / and bio fertilizer might due to pigeon manure of content some minerals (N, P, K, Fe, Zn, Mn and Cu), which have a great role in cell division and enlargement and induce the photosynthesis which in reflect on growth parameters. This result might be due to effect of yeast role in producing important substances like growth regulators (cytokinins, gibberellins, auxins), which led to improve the metabolic processes rate. These results coincide with those obtained by Ahmed, *et al* 2011, Aram, 2012, El-Dissoky *et al* 2013. [19, 20, 9], who reported that grain yield was significantly affected by maize genotype. The grain yield is the function of combined effect of all the yield components under the influence of a particular set of environmental conditions.

This increase in grain yield per plant with 10t/fad pigeon manure + foliar of yeast bread might be due to improve nutrient use efficiencies and normal development of the maize plant with increasing number of row per ear , ear length and ear diameter. In this respect, Hellal *et al.,* 2014 [15] stated that the yield and yield attributing characters *viz.* 100 grain weight, and grain yield of maize exhibited response to manure application.

These increases inyields and its components as a result of application of the pigeon manure with yeast bread application may be attributed to high content of micronutrients, whichmight enhance the activity of photosynthesis and protein synthesis in the leaves. Thisin turn encourages photosynthetic process and dry matter accumulation more actively. The elemental composition of the pigeon manure applied especially their content of N, P, K, Fe, Mn, Zn and Cu may accountfor such finding. Beneficial microorganisms in bio-fertilizers accelerate and improveplant growth and protect plants from pests and diseases [21].

Farnia and Torkaman (2015) [22] reported that bio-fertilizer application which accounts important benefit to the maize producers and maize production, causing decreasing in the inputs of production because of economizing much money to chemical fertilizers and increasing in yield and biological yield. The same trend, Habtamu *et al.,* (2015) [23] pointed out the use of integrated organic and inorganic fertilizers should be recommended for farmers because they were affordable options for increasing maize yields with improving soil fertility in the small-scale farming systems of the study.

These results may be due to the beneficial effect of pigeon manure and yeast on metabolic processes and growth which in turn reflect positively on carbohydrate and protein of maize grain. These results are confirmed by the finding of Ayeni *et al.*, (2012) [24], who confirmed that application of bio-fertilizers became of great necessity to get a yield of high quality and to avoid the environmental pollution. Utilization organic source of fertilizer to avoid lethal effects on human health created by inorganic fertilizers [25]. Similar results were obtained by, Hussein *et al*., (2012) [26], Ahmed *et al.,* (2015) [14] and obid *et al.,* (2016) [27].

4 Conclusion

Soil fertility and corn productivity are continuously declining due to the removal of essential plant nutrients from the soils. The deficiencies of essential plant nutrients, organic matter, and beneficial soil microbes in soils had negative impact on soil fertility. Result of the study revealed that using pigeon manure at the rate of 10 ton/fad + foliar of yeast bread help in improving plant growth parameters, yield and chemical contents of maize plant under the circumstances of Wadi El-Rayan, Fayoum Governorate, Egypt as it is maintaining the soil health, flourishes the rhizosphere micro-flora by providing nutrients that stimulate growth of plants and more safe to the evironment. Moreover, we recommend High tech-2031 cultivar to grow in this district.

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