Journal of Crop Nutrition Science
ISSN: 2423-7353 (Print) 2538-2470 (Online)
Vol. 5, No. 2, 2019
http://JCNS.iauahvaz.ac.ir **OPEN ACCESS**

Investigating Effect Different Level of Fertilizer, Biofertilizer and Sugarcane Compost on Agrophysiological Characteristics of Maize (S.C 703)

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RESEARCH ARTICLE

ARTICLE INFO.
Received Date: *29 Mar. 2019*
Received in revised form: *4 May. 2019*
Accepted Date: *5 Jun. 2019*
Available online: *30 Jun. 2019*

To Cite This Article:
Akbar Talebzadeh, Seyed Kivan Marashi. Investigating Effect Different Level of Fertilizer, Biofertilizer and Sugarcane Compost on Agrophysiological Characteristics of Maize (S.C 703). ***J. Crop. Nutr. Sci.,*** 5(2): 47-56, 2019.

ABSTRACT

BACKGROUND: Soil nutrition management is an important factor, which determines the plant growth. Soil fertility is determined by the presence or absence of nutrients i.e. macro and micronutrients, which are required in optimum level for crop.

OBJECTIVES: Evaluate the effect different amount of nitrogen and phosphorus fertilizers in maize field under sugarcane compost consumption on leaf area index, total dry weight and seed yield.

METHODS: Current research was conducted according a split block experiment based on randomized complete block design with three replications. The first factor included biological and chemical nitrogen fertilizers in 3 levels (a_1: completely nitrokara, a_2: 25% urea plus nitrocara and a_3: 50% urea plus nitrokara) also the second factor, including biological and chemical phosphorus fertilizer in three levels (b_1: phosphorus biofertilizer, b_2: 25% triple super phosphate plus phosphorus biofertilizer, b_3: 50% triple super phosphate plus phosphorus biofertilizer).

RESULT: The results of analysis of variance indicated that the effect of different levels of nitrogen chemical and biofertilizer on plant height, leaf area index, total dry matter, crop growth rate and net photosynthesis rate were significant at 1% probability level. Also the effect of different levels of phosphorus chemical and biofertilizer in all traits was significant at 1% probability level. The interaction effect of treatments on total dry weight was significant at 5% probability level and did were not significant difference for other traits. Mean comparison of different level of main factor was observed in consumption of 50% of urea plus nitrokara and completely nitrokara treatment, respectively. Also Among different levels of subfactor the maximum and minimum amount of measured traits were observed in 50% triple super phosphate plus phosphorus biofertilizer and completely phosphorus biofertilizer treatment, respectively.

CONCLUSION: Generally result of current research revealed that use of nitrogen and phosphorus chemical and biological fertilizers in field with sugarcane compost had a positive effect on measured traits of wheat and finally consume 50% urea plus nitrokara with 50% triple super phosphate plus phosphorus biofertilizer was achieved maximum amount of measured traits and can be advised to farmers.

KEYWORDS: *Corn, Growth curves, Phosphorus, Plant height, Urea.*

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1. BACKGROUND

Maize (*Zea mays* L.) is grown among crops due to high consumption, high quality and high nutritional value, cultivated in a large part of the world and more than 500 different types of products are obtained from it. It has been stated that in a corn farm with 10 to 12 tons per hectare, it absorbs about 200-300 kg of nitrogen, 80-120 kg of phosphorus and 200-300 kg of potassium per hectare (Emam, 2007). Currently, in order to increase the production of agricultural products, the most producers have used chemical fertilizers, but the use of chemical fertilizers in the long term has damaged the physical and chemical properties of soils and with decreasing the permeability of the soil, the root expansion of the plants has become difficult and it will be result in reduction in yield, also causes environmental problems and pollution of groundwater (Wu *et al*., 2004). Recently, the world food and agricultural organization has proposed the development of integrated systems for organic fertilizers and chemical fertilizers for developing countries (Griff *et al*., 2003). According to researches, the combination of chemical fertilizers with organic and biological resources has good results in increasing the productivity of agricultural production, which can be a step toward sustainable agriculture (Karla, 2003). The term of biological fertilizers refers to bacterial or fungal microorganisms and the ingredients derived from their activities. This group of biofertilizers improves the yield of crops, in addition to increasing the amount of mineral elements in soil through biological stabilization of nitrogen, inhibition of pathogenic factors and the production of plant growth regulating agents, improves the crop yield (Sturz and Christie, 2003). Organic and chemical fertilizers are necessary for each other and both are needed to create the proper conditions for plant growth. One of the adverse effects of long-term and overexploitation of chemical fertilizers is the reduction of soil fertility following the disappearance of humus. Another interesting point is that not only there are no harmful or negative effects between chemical and organic fertilizers, but these two types of fertilizers are complementary and compensate for the shortcomings of each other. Organic fertilizers have improved the effect of chemical fertilizers and chemical fertilizers increase the yield of organic fertilizers by increasing the yield of agricultural products (Malakouti, 2005). Biofertilizers such as Nitrokara can be mentioned. This fertilizer contains bacteria that, in addition to nitrogen fixation of the air, can produce anti-fungal compounds against plant diseases and enhance the germination and plant breeding, which leads to the growth of plants (Saleh Rastin, 2001). These bacteria, by balancing the absorption of high-energy and micronutrient elements, secretion of amino acids and the types of antibiotics, cause the growth of the roots and parts of the air and thus lead to increased crop yields in plants (Block, 2011). The response of cereals to inoculations with Nitrokara is different in terms of bacterial strains and soil and weather conditions in the

region and in positive response cases, the increase in the product is reported to be about 7 to 12% and up to a maximum of 39% (Khavari, 2010). The fertilizer of Potabarvar-2 contains useful phosphorus-soluble bacteria that, by acidifying the soil and secreting phosphatase enzymes, release phosphate ions from phosphorus compounds that are absorbed by plants. These fertilizers, in addition to increasing fertilizer yield, also increase the yield significantly (Saleh Rastin, 2001). According to Zodape (2001), the increased yield of products results from the use of biofertilizers due to the trace of micronutrient elements and growth regulators resulting from these fertilizers. Nasrollahzadeh *et al.* (2017) stated that the highest index of corn leaf area was obtained by using 50% of fertilizer, while simultaneous consumption of six tons per hectare of vermicompost and 50% of fertilizer was ranked second.

2. OBJECTIVES

This study was designed and conducted to evaluate the effect of application of chemical and biological fertilizers on the agrophysiological traits of maize in areas with sugarcane compost to reduce the use of chemical fertilizers.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

This Study was conducted in the summer of 2016 at the educational-research field of Islamic Azad University in northeastern Ahwaz with latitude 31° and 29 minutes north and longitude 48° and 54 minutes east with a height of 15 meters above sea level. To do the experiment, samples were taken at a depth of 0-30 cm, the result of soil properties were shown in table 1. Current research was conducted according a split block experiment based on randomized complete block design with three replications. The first factor included biological and chemical nitrogen fertilizers in 3 levels (a_1: completely nitrokara, a_2: 25% urea plus nitrocara and a_3: 50% urea plus nitrokara) also the second factor, including biological and chemical phosphorus fertilizer in three levels (b_1: phosphorus biofertilizer, b_2: 25% triple super phosphate plus phosphorus biofertilizer, b_3: 50% triple super phosphate plus phosphorus biofertilizer). Nitrokara (nitrogen biofertilizer) and potabarva-2 (phosphorus biofertilizer) were used by spraying on the seed before planting.

Table 1. Physical and chemical analysis of soil

Depth of soil	K (ppm)	P (ppm)	N (%)	O.C (%)	pH	E.C ($ds.m^{-1}$)	Clay (%)	Silt (%)	Sand (%)	Soil Texture
0-30	196	18.5	0.04	0.51	7.15	6	32	49	19	Sily clay

3.2. Farm Management

Urea and triple superphosphate fertilizer were 240 and 100 kg N and P pure per hectare according to the custom of the region, respectively, and percentage of them were used according to the type of treatment. Urea fertilizer was applied in two stages before and after planting

in 4-6 leaf stage with irrigation water. Triple superphosphate fertilizer was used before planting. In this experiment, the base fertilizer was placed in accordance with the custom of the area with the help of a disk machine at a depth of 20 to 15 cm. After preparing the feild and before planting, 30 tons per hectare of compost from the sugarcane residue was mixed with the soil with the help of a disk machine. Sugar compost was prepared from Shushtar animal feed company under the supervision of Karoun Crop Industry Company. This experiment was consisted of 3 repetitions and 27 strips (blocks). Planting were done according to furrowing method, spacing between planting lines was 0.75 m, and the spacing of the seeds on the sowing line was 20 cm.

3.3. Measured Traits

Plant height in each plot was measured in 5 plants randomly up to the end of tassel. Measurement of growth indices such as leaf area index, dry matter accumulation in three stages of emergence of tassel, emergence of silk and seed filling stage were taken from 5 plants per plot. To measure the dry matter, the samples were dried in an oven for 48 hours at 72 ℃ and their dry weight was determined using a digital scale with a precision of 0.01.

3.4. Statistical Analysis

The data were analyzed by using with the SPSS (Ver. 22) software and mean comparison were done by Duncan multiple range test at 5% probability level.

4. RESULT AND DISCUSSION

4.1. Plant height

Result of analysis of variance showed that the effect of nitrogen and phosphorous chemical fertilizers on plant height was significant at 1% level, but their interaction was not statistically significant (Table 2). The maximum plant height in nitrogen fertilizer application by 199 cm was obtained in 50% Urea fertilizer plus Nitrokara biological fertilizer and the minimum plant height with 178 cm abtained in alone nitrokaria fertilizer application (Table 3). The reason for increasing the height in terms of application of 50% of urea fertilizer can be attributed to the effect of nitrogen intensification on vegetative growth and cell division in the plant, especially on the stem. It can also stated that the presence of nitrate fertilizer, soil properties such as organic matter content and increasing access to nitrogen, phosphorus, potassium and micro elements improve, and these effects intensify in the presence of chemical fertilizer. The results of this experiment were consistent with the findings of Seyed Sharifi and Nazarli (2013), which showed that the application of bacteria with 160 $kg.ha^{-1}$ of urea fertilizer increased the plant height. It is also stated that under nitrogen conditions, photosynthetic materials are more produced and these materials provide suitable conditions for stem elongation. In addition, biological fertilizers have been reported to affect plant growth through the production of hormones that stimulate growth, especially auxin (Krism, 2018).

Potals (2017) reported that the maximum plant height was produced in rice plant with the use of biological fertilizers with consumption of 180 kg.ha^{-1} nitrogen. The results also showed that the highest plant height in the application of phosphorous fertilizers by 189 cm due to application of 50% triple super phosphate fertilizer plus potabarvar-2 and the minimum of that (187 cm) in terms of alone application of barvar- 2 was obtained (Table 3). Eydizadeh *et al*., (2010) also described the effect of the combined application of biological fertilizers with chemical fertilizers in maize, and reported which increased the plant height in terms of their combined application compared to the individual application of each fertilizer, which was consistent with the results of this experiment. Probably the main reason of that matter due to increasing absorption of food by the plant in the combined application. Zahir *et al*. (1998) also reported an increase in corn heights affected by inoculation with phosphorus-soluble bacteria, such as Pseudomonas.

Table 2. Result analysis of variance of measured traits

S.O.V	df	Total dry weight			Leaf Area Index			Seed yield
		Beginig of flowering	Tassel emergemce	Grain filing period	Beginig of flowering	Tassel emergemce	Grain filing period	
Replication	2	10778^{ns}	10192^{ns}	9916^{ns}	0.016993^{ns}	0.004493ns	0.000904^{ns}	3249^{ns}
Nitrogen (N)	2	118663**	127206**	111333**	0.350648**	0.117315**	0.244326**	76629**
Error I	4	2814	1565	1649	0.002731	0.001581	0.004126	1059
Phosphorus (P)	2	28369**	29684**	27608**	0.012226*	0.006693**	0.008159**	31532**
Error II	4	282	353	319	0.001309	0.000309	0.000243	479
N×P	4	1199^{ns}	1346*	1264*	0.001281^{ns}	0.000081^{ns}	0.001348^{ns}	195*
Error III	8	370	309	312	0.000781	0.000148	0.000448	51
CV (%)	-	1.8	1.2	1.4	0.7	0.4	1.1	1.3

$^{ns, *}$ and **: Non–significant and significant at 5% and 1% probability levels, respectively.

4.2. Total dry weight (*TDW*)

The results showed that the effect of chemical and biological nitrogen fertilizer, and chemical and biological phosphorus fertilizer and their interaction on total dry weight were significant (at all growth stages) at 1% statisticall probability level (Table 2). The highest total dry weight was obtained from treatment with 50% Urea fertilizer plus Nitrokara biological fertilizer and 50% Triple Super phosphate fertilizer plus potabavar-2 and the minimum of it was obtained in alone application of Nitrokara and barvar-2 (Table 4). It seems that the effect of biological fertilizers on the total dry matter increases with increasing of chemical fertilizer application. Eydizadeh *et al*. (2010) stated that biological fertilizers increase the root contact with

soil and ultimately increase the absorption of nutrients. Mentioed researchers also stated that the production of various acids by bacteria could lead to more organic solubility of the soil. It seems that the effect of bio-fertilizers provides up to 50% of the plant's nutritional requirements, and the rest of the plant's needs must be provided through the use of chemical fertilizers. The results of Stancheva *et al*. (1992) also indicated that corn dry weight increased by corn inoculum with biological fertilizers. That researchers also mentioned that matter due to the increase in access and the absorption of nutrients. In this regard, Hojattipor *et al*. (2014) reported that the maximum total dry weight was obtained in wheat with increasing nitrogen fertilizer up to 225 $kg.ha^{-1}$, along with biological nitrogen fertilizer of nitrokara. Noraki *et al*. (2017) reported that the spraying of biological fertilizers containing amino acids along with nitrogen fertilizers increases the growth and production of dry matter. Application of fertilizer of triple super phosphate 50% with bio-phosphate had a significant effect on increasing total dry weight of corn.

Table 3. Mean comparison effect of different level of nitrogen and phosphorus on leaf area index along different growth stage

Treatment	Leaf Area Index		
Nitrogen	**Beginig of flowering**	**Tassel emergemce**	**Grain filing period**
Nitrokara	3.99c	3.17c	2.01c
Nitrokara+25% Urea	4.17b	3.3b	2.19b
Nitrokara+50% Urea	4.38a	3.4a	2.34a
Phosphorus			
Biofertilizer Barvar2	4.14c	3.26c	2.15c
Biofertilizer Barvar2 + 25% triple super phosphate	4.19b	3.29b	2.18b
Biofertilizer Barvar2 + 50% triple super phosphate	4.21a	3.32a	2.21a

*Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level.

4.3. Leaf area index (*LAI*)

The results showed that the effect of biolological and chemical nitrogen and phosphorous fertilizer (at all stages) was significant at 1% and 5% probability level, respectively. However, the interaction effect of treatment was not significant (Table 2). The maximum of leaf area index in application of nitrogen biological and chemical fertilizer at different stages of growth was obtained of application of 50% urea fertilizer plus biological nitrogen fertilizer. The maximum of leaf area index at different growth stages was obtained under alone application of nitrokara fertilizer (Table

3). The results of Eydizadeh *et al*. (2010) also showed that the maximum leaf area index was obtained from the application of nitrogen fertilizer combination with biological nitroxin fertilizer and the minimum of that was achieved under alone application nitroxin fertilizer. It has been reported that nitrogen increase the vegetative growth of maize, which leads to an increase in leaf number and leaf area index (Ayub *et al*., 2003). One of the reasons for increasing the leaf area in the treatment of inoculated with growth promoting bacteria can be introduce such as the production of various types of metabolites effective in plant growth like vitamins, growth hormones and amino acids as growth enhancers, Nitrogen bio-stabilization or Phosphorus, sulfur and other nutrients especially micronutrients in the soil and extension of the root surface caused by the activity of bacteria, followed by increased absorption of nutrients by the root (Gholami *et al*., 2009). The results also showed that the maximum of leaf area index in the application of chemical and biological phosphorus fertilizers in all stages of growth abtained under 50% triple superphosphate plus barvar-2 and the minimum of that achieved under alone application of barvar-2 (Table 3). The results of this study were consistent with findings of Hamzei and Babaei (2016), they reported the corn leaf area index was increased by application of 40% phosphate fertilizer plus mycorrhiza and the minimum of that was achieved in the alone application of mycorrhizal. That matter can be attributed to availability the most essential elements for growth and ultimately, to the improvement of vegetative growth and leaf development.

Table 4. Mean comparison interaction effect of treatment on total dry weight and seed yield

Nitrogen	Phosphorus	Total dry weight ($gr.m^{-2}$)		Seed yield ($kg.ha^{-1}$)
		Tassel emergemce	Grain filing period	
Nitrokara	Biofertilizer Barvar2	1405.2ef	1339.7d	4401.1d
	Biofertilizer Barvar2 + 25% triple super phosphate	1451.3e	1383.8cd	5200.6cde
	Biofertilizer Barvar2 + 50% triple super phosphate	1472.4de	1404.7c	5494.8c
Nitrokara +25% Urea	Biofertilizer Barvar2	1477.5de	1408.0c	5347.7cd
	Biofertilizer Barvar2 + 25% triple super phosphate	1557.3cd	1484.3bc	6047.2bcd
	Biofertilizer Barvar2 + 50% triple super phosphate	1600.0c	1524.7b	6393.9b
Nitrokara+50% Urea	Biofertilizer Barvar2	1598.1c	1517.8b	6141.5bc
	Biofertilizer Barvar2 + 25% triple super phosphate	1694.0b	1613.0ab	7013.8ab
	Biofertilizer Barvar2 + 50% triple super phosphate	1747.8a	1662.8a	7476.9a

*Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level.

4.4. Crop growth rate (CGR)

The results of analysis of variance showed that the effect of nitrogen and phosphorus fertilizers on the crop growth rate was significant at 5% probability level, but interaction effect of treatment was not significant (Table 2). The maximum crop growth rate was observed in the treatment of 50% chemical fertilizers plus biological fertilizers and the minimum of that was for alone consumption of each biological fertilizer (Table 3).

4.5. Net assimilation rate (*NAR*)

The results of analysis of variance showed that the net assimilation rate under nitrogen fertilizer application was significant at 5% probability level, but the effect of phosphorus fertilizers and the interaction of treatments was not significant (Table 2). The maximum net assimilation rate under the application of nitrogen fertilizers was achieved in 50% urea fertilizer plus nitrokara biological fertilizer and the minimum of that were obtained under the alone application of nitriokara fertilizer (Table 3). It has been stated that the application of bio-fertilizers with nitrogen, significantly increases the carbon dioxide absorption and increases the efficiency of photosynthesis in corn (Farrokhi and Eridatmandasli, 2008). Otolz (2015) stated the use of azetobacter with urea fertilizer leads to an increase in the net assimilation rate and CO_2 absorption. Because the bacteria in these biofertilizer stimulate the root growth and they provide conditions for nitrogen uptake, and by expanding leaf area and chlorophyllation, it leads to more solar radiation absorption and assimilation.

5. Conclusion

Generally, the results showed that the application of chemical and biological fertilizers under sugarcane compost conditions is effective to improve the physiological parameters of corn, and this effect is more pronounced in the combined application of bio-fertilizers with chemical fertilizers than the alone application of biofertilizer. In this research, the best situation was achieved through the consumption of 50% chemical fertilizer and simultaneous consumption of nitrokara and barvar-2, which could be considered by researchers and farmers.

ACKNOWLEDGMENT

The authors thank all colleagues and other participants, who took part in the study.

FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

CONFLICT OF INTEREST: Authors declared no conflict of interest.

FUNDING/SUPPORT: This study was done by scientific support of Department of Agronomy, Islamic Azad University, Ahvaz Branch.

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