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The Effect of Application of Biological Phosphate Fertilizer (Fertile 2) and Triple Super Phosphate Chemical Fertilizers on Some Morphological Traits of Corn (SC704)

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Abstract**—**In order to study the effect of different levels of triple super phosphate chemical fertilizer and biological phosphate fertilizer (fertile 2) on some morphological traits of corn this research was carried out in Ahvaz in 2002 as a factorial experiment in randomized complete block design with 4 replications). The experiment included two factors: first, biological phosphate fertilizer (fertile 2) at three levels of 0, 100, 200 g/ha; second, triple super phosphate chemical fertilizer at three levels of 0, 60, 90 kg/ha of pure phosphorus (P2O5). The obtained results indicated that fertilizer treatments had a significant effect on some morphological traits at 1% probability level. In this regard, P2B2 treatment (100 g/ha biological phosphate fertilizer (fertile 2) and 60 kg/ha triple super phosphate fertilizer) had the greatest plant height, stem diameter, number of leaves and ear length. It seems that in Ahvaz weather conditions, decrease of consumption of triple superphosphate chemical fertilizer to less than a half along with the consumption of biological phosphate fertilizer (fertile 2) is highly important in order to achieve optimal results. Therefore, it can be concluded that biological fertilizers can be used as a suitable substitute for some of the chemical fertilizers in sustainable agricultural systems.

Keywords**—**Biological phosphate fertilizer, corn (SC704), morphological, triple super phosphate.

I. Introduction

DUE to its increasing importance in feeding humans and cattle and its wide compatibility with temperate and tropical climate zones, Maize (*Zea mays* L.) is considered as one of the strategic crops [22].

The increase of corn acreage over the past few decades, compression of cultivation systems of this crop, along with high need of corn to nutrients not only have increased the excessive consumption of chemical inputs, but also have increased production costs and environmental risks [1].

One of the new subjects of sustainable agriculture in soil resources management is investigating soil organisms and useful mutual symbiotic relations between components of ecosystem in food chains and vital cycles. Since in most cases quantity and quality of soil organisms are not sufficient, biological fertilizers, which are preservatives with a dense mass of one or several kinds of useful soil organisms or as metabolic products of such organisms, have been produced to provide the nutrients that plans need [14]. Application of biological products for feeding grains is one of the useful solutions to achieve a part of sustainable agriculture goals [12].

Phosphorus is one of the main elements required by plants. However, unusual and excessive consumption of phosphorous fertilizers has unfortunately imposed deleterious effects on agricultural community [6]. Nutrients imbalance in plants and the decrease of crop yield are among these effects [13]. Biological fertilizers are made up of useful bacteria and fungi each of which is produced for a particular purpose. Such bacteria are usually settled around the roots and help absorb a certain element and cause the absorption of other elements and plant further growth [24]. One of these fertilizers is phosphate bio-fertilizer (fertile 2). Its high capability as a solvent for phosphate, climatic adaptability, stability during the storage, easy consumption, cheap transport, and compatibility with other fertilizers and pesticides are mentioned as the features of this kind of fertilizer [15]. Jat and Shaktawat [5] showed that phosphate bio-fertilizer in comparison to triple super phosphate fertilizers considerably increased the yield. Phosphate solubilizing bacteria secrete phosphatase and organic acids and thus make phosphate solution and increase the phosphate uptake by plants. MirzaBagheri et al. [8] and Toro et al. [19] showed that the use of phosphate solubilizing bacteria increased the concentration of nitrogen and phosphorus in vegetative organs in comparison to the control treatment without using them. In an experiment, Peix et al. [10] reported that the use of phosphate solubilizing bacteria caused the increase solubility of insoluble phosphorus, increase of phosphorus uptake, and significant increase of yield in barley and peas. Sylvia et al. [16] concluded that in treatments which used phosphate biological fertilizer, the concentration of phosphorus and copper increased in corn's shoots and seeds. Goenadi et al. [3] reported that the use of bio-fertilizers and 50-75% chemical fertilizer led to a yield similar to the yield of the consumption of 100% chemical fertilizer.

This research was carried out in order to achieve the goals of sustainable agriculture and to decrease the use of chemical fertilizers and also to examine the effects of phosphate bio-

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fertilizer (fertile 2), as an economically and environmentally efficient and a healthy fertilizer source, on some morphological traits of corn.

II. Materials and Methods

This research was carried out in Shahid Salemi field 36 km away from northeast of Ahvaz at latitude °31 ´36 and longitude°48´ 53 and 51 m above the sea level. The kind of soil used in the experiment was clay loam with pH=7.8 and EC=6.7 It was a factorial experiment as randomized complete block design with 3 replications and two factors. The first factor included biological phosphate fertilizer (fertile 2) at three levels of 0, 100, 200 g/h and the second factor included triple super phosphate chemical fertilizer at three levels of 0, 60, 90 kg/ha of pure phosphorus (P_2O_5). The needed corn seeds were moistened by a little water before planting and were mixed by the contents of a 100-g package of phosphate biological fertilizer (fertile 2) as the desired factors in the experiment and then after complete drying of the seeds in the shade, they were planted manually by considering the density of 75000 plants per hectare in a space of 18 cm from each other on one side of the stack. The seeds were planted in early August. Each plot contained 6 planting lines as long as 5m and as distant as 75 cm from each other. Nitrogen was used from urea source as much as 180 kg in two stages, so that 90 kg was used during the planting and the rest was added then as the head. Triple super phosphate fertilizer was used to provide the needed phosphorus according to each treatment need. In this experiment, morphological traits such as plant height, stem diameter, number of leaves, and ear length in corn were examined.

At the end of the research, date were statistically analyzed using SAS software and the means were compared by Duncan's multi range test at 5% level and the diagrams were drawn by Excel software.

III. Result and Discussions

Plant height was significantly affected by phosphate bio-fertilizer (fertile 2) and triple super phosphate (P≤0/01). Triple super phosphate inoculation with phosphate bio-fertilizer (fertile 2) increased plant height significantly (P≤0/01) (Table I). Mean comparison results showed that the highest plant height by 208.33.cm belonged to treatment with 60 kg/ha triple super phosphate chemical fertilizer and the height of 220.66 cm belonged to application of 100 g/ha phosphate bio-fertilizer (fertile 2). Like other vegetative and reproductive organs, plant height is extremely affected by nutrients and water. Plant access to sufficient water and nutrients particularly phosphorus and nitrogen will increase plant height through influencing the division and growth of cells. In a research, application of phosphorus fertilizer in soils that lacked phosphorus significantly increased plant height [4].

TABLE I
The ANOVA Results of Some Morphological Traits of Maize

S.O.V	Df	Ear Length	Stem Diameter	Number of Leaves	Plant Height
Block	2	4.98 **	0.002 n.s	0.63 n.s	3.37 n.s
P	2	24.75 **	0.629 **	6.33**	2240.03**
B	2	49.33 **	0.102 **	5.33**	229.48**
P*B	4	0.43 n.s	0.003 n.s	1.33 n.s	9.53 n.s
Error	16	0.885	0.007	0.753	5.45

NS, not significant **and* significantly on probability level of 1 and 5%, respectively

On the other hand, the solubility of insoluble phosphates by phosphorus solubilizing microorganisms and the secretion of growth enhancers such as auxin, gibberellins and cytokinin by such microorganisms can increase the root and crop growth [25], [7]. The increase of nutrients absorption and photosynthesis improvement and synthesis of materials due to increase of leaf area could be the other reasons of increase of plant height. The results were consistent with the findings of [9] which showed that consumption of biological fertilizers along with chemical fertilizer could increase the plant height. Mirzabagheri et al. [8] showed that consumption of bio-fertilizer had a significant effect on plant height of sunflower. Moreover, [18] showed that consumption of nitrogen and phosphorus biological fertilizers together not only increased soybean height, but also decreased the rate of phosphate chemical fertilizers up to 50% at presence of phosphate solubilizing bacteria. Shamsi Mahmoud Abadi et al. [15] showed that phosphate bio-fertilizer (fertile 2) and triple superphosphate (50 kg/ha) increased plant height in forage corn. Rousta et al. [12] reported the increase of plant height in corn hybrid SC 704 in the presence of biological fertilizers. Presence of biological fertilizers improves soil properties such as organic matter content and increases access to nitrogen, phosphorus, potassium, and microelements. Such effects have been intensified in presence of chemical fertilizers.

Number of leaves was significantly affected by phosphate bio-fertilizer (fertile 2) and triple super phosphate ($P \leq 0.01$). The interactive effect of phosphate bio-fertilizer (fertile 2) and triple super phosphate on the number of leaves was significant, too (Table I). Mean comparison results showed that the highest number of leaves by 7.66 belonged to the treatment without application of triple super phosphate chemical fertilizer and also the treatment with consumption of 60 and 100 g/ha phosphate bio-fertilizer (fertile 2) by 7.33. Simultaneous application of chemical and bio-fertilizers will increase the number of leaves. Leaves, as the main plant organ for doing photosynthesis and producing assimilates in plant are highly important. As the number of leaves and their area increase, plant can make use of light sufficiently in order to synthesize food and the rate of photosynthesis will increase [17].

The results were consistent with the findings of [15] which showed that phosphate bio-fertilizer (fertile 2) plus triple super phosphate by 50 kg/ha, increased the number of leaves in forage maize. Moreover, [11] showed that experimental treatments including bio-fertilizers like nitroxin, phosphate

(fertile 2), bio sulfur and their combination, and chemical fertilizer treatment (urea, triple super phosphate, potassium sulfate) and control treatment (lack of application of fertilizer) had significant effects on the number of leaves in the herb of *Dracocephalum moldavica* L.

Stem diameter was significantly affected by phosphate bio-fertilizer (fertile 2) and triple super phosphate separately ($P \leq 0.01$). (Table I). Mean comparison results showed that the highest stem diameter by 2.28 cm belonged to the treatment with application of 60 kg/ha triple super phosphate chemical fertilizer, and also the treatment with application of 100 g/ha phosphate bio-fertilizer (fertile 2) by 2.47 cm.

The results were consistent with the findings of [22] which showed that inoculation of grain of maize SC 604 with phosphorus solubilizing bacteria and growth promoting bacteria and consumption of adequate input increased the stem diameter significantly in comparison to control treatment.

Ear length was significantly affected by phosphate bio-fertilizer (fertile 2) and triple super phosphate separately ($P \leq 0.01$) (Table I). In other words, inoculation with bio-fertilizer (fertile II) significantly increased the length of ear (Table II).

Mean comparison results showed that the highest ear length by 22.72 cm belonged to the treatment with application of 60 kg/ha triple super phosphate chemical fertilizer, and also the treatment with application of 100 g/ha phosphate bio-fertilizer (fertile 2) by 22.98 cm.

TABLE II
MEAN COMPARISON OF THE EFFECTS OF LEVELS OF TRIPLE SUPER PHOSPHATE AND BIOLOGICAL PHOSPHATE FERTILIZER (FERTILE 2) ON SOME MORPHOLOGICAL

Treatment	Ear length (cm)	Stem diameter (cm)	Number of leaves	Plant height (cm)
P				
P1 (0 kg/ha)	19.52 c	1.95 c	7.66 a	189.44 c
P2(60 kg/ha)	22.72 a	2.28 a	7 b	208.33 a
P3 (90 kg/ha)	21.87 b	2.14 b	6 c	201.11 b
B				
B1 (0 g/ha)	18.68 c	2.07 b	6 b	198.33 c
B2 (100 g/ha)	22.98 a	2.47 a	7.33 a	220.66 a
B3 (200 g/ha)	22.44 b	2.21 a	7.33 a	204.55 b

*: In each column and each group cares with same letter had no significant differences in probability level of 5% based on Dunken multiplerange test

In several experiments, the increase of ear length in barley, in wheat, in barely and also the increase of ear length in maize due to application of phosphate solubilizing bacteria were reported [2], [10], [20], [21]. In the experiment organic and integrated treatments had the highest effect on increase of ear length of Isabgol (*Plantago ovata*) herb [23].

IV. CONCLUSION

The results of the present research showed that application of biological fertilizer could increase some morphological traits in maize; therefore, application of biological fertilizers not only reduced the consumption of chemical fertilizers and their potential economic and environmental consequences significantly but also had more favourable effects on growth of maize. In fact, phosphate bio-fertilizer (fertile 2) in combination with appropriate level of triple super phosphate chemical fertilizer will gradually release phosphorus and change it into absorbable form by plants and thus will reduce the plants need to phosphate chemical fertilizers and increase their efficiency.

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