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Economical Analysis of Bio-Chemical Fertilizers Usage on Corn yield under three different Irrigation Regimes

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ABSTRACT

Nowadays, Mycorrhizal fungi are widely used due to their symbiosis relation with roots of so many plants. These fungi, by supplying some of plant nutritional and water requirements, have a key role in all ecosystems. In this research the economic analysis of the effects of mycorrhizal fungi and different levels of phosphorous chemical fertilizers on yield and nutrient uptake under three levels of irrigation were studied. This experiment was performed in a split factorial design with four replications. Irrigation under three levels of irrigation (60,120 and180 mm according to class A vapor basin) were placed in the main plots at different levels of phosphorus (0, 60 and 120 kg/ha) and mycorrhizal fungi (6 g per seed) were placed in the subplots. The results indicated that the effects of Mycorrhizal inoculation were statistically significant and positive on measured characteristics. Among triple interactions irrigation/chemical phosphorus/mycorrhizal inoculation had significant effects in A2P60G 4883 kg/ha) on grain yield and Results showed that in moderate water stress, by using proper amount of chemical phosphorus and mycorrhizal inoculation can increase in grain yield and by decreasing in total costs as economical view can be increase in income. Moreover, under water stress, mycorrhizal inoculation improved most of measured indexes. Regard to cost table for planting until harvesting period of produce for corn (table 1) with less using of chemical fertilizer and increasing in period of irrigation instead of 1 week to 2 week also show in this research we can less expenditure produce for increasing in produce potential and proper method to produce more healthy food. Treatments a2p60G, a2p120G, a1p60Gwere in a statistical group and had higher grain yield than other treatments. Regard to cost table for planting until harvesting period of produce for corn (table 1) with less using of chemical fertilizer and increasing in period of irrigation instead of 1 week to 2 week also show in this research we can less expenditure produce for increasing in produce potential and proper method to produce more healthy food. Treatments a2p60G, a2p120G, a1p60G were in a statistical group and had higher grain yield than other treatments, given the high cost in compare irrigation in 14 days, favorable treatment and diagnosis a2p60G is introduced therefore this kind of bio fertilizer with proper amount of chemical fertilizers by decreasing in total produce costs can have an important key role in agriculture of arid and semiarid climates.

Key words:

Introduction

Water is much necessary for plant growth and production because of its important functioning in plant including solubilization and hence uptake of nutrients and their movement in the plant, plant transpiration, and creating the necessary pressure for the growth and development of plant cells Hence, under drought stress plant activities such as photosynthesis, activities of nitrate reducing and hydrolyzing enzymes (like amylase) decrease, which eventually reduce plant growth and production [17]. Plant morphological and biochemical responses to drought stress vary with stress intensity. Corn cellular development decreases under moderate to medium drought stress, which eventually reduces plant growth [9]. Lam [10] showed that corn can be planted using minimum level of irrigation water. Nonetheless, under such conditions corn yield and some of its qualitative characters may be adversely affected. Many researchers have indicated that arbuscular mycorrhizal (AM) fungi are capable of alleviating the unfavorable effects of drought on plant growth [2,16]. Symbiotic relationship between AM fungi and a variety of plants produces colonies on the exterior part of root system resulting in the enhanced uptake of water and nutrients by the plant roots. Such characters improve plant performance

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under drought stress, which is believed to be in part related to the increased absorption of water and some nutrients such as zinc (Zn) and copper (Cu) improved plant variables may include leaf height, leaf water turgidity, stomatal activities, and root growth and development [6]. AM fungi perform as the enhancer of plant-water relationship through increasing stomatal resistance by adjusting plant hormonal balance. Moreover, this chain of improvements enhances plants phosphorous (P) nutrition introduced by AM fungi activities under growth conditions [3]. Morton calculated the economical role of arbuscular mycorrhizal fungi only in respect to supplying phosphorus demant of plants in different ecosystems. According to his data in crops the role of mycorrhizal fungi in phosphorus nutrition is equal to $78 bilion each year. Phosphorous is one of main elements needs for plants. This element in flowering, root extending and grain yield have necessary roles. One of `the benefit methods for efficiency if use the phosphorous is apply of AM fungi. Mycorrhizal fungi by symbiosis with plants roots and extending hyphae's into soils be cases absorption better phosphorous. In corn and sorghum, leaf surface, weight of dried aerial organs, net surface of leaves, pressure potential of the wooden vessel, and water and soil potentials proved to be the same in phosphorus and mycorrhizal treatments [20]. George et al. [5] declared that root mycorrhizal symbiosis percentage had a negative correlation with the amount of phosphorus exist in the soil. Shiranirad [26] found out that mycorrhizal symbiosis had the statistically significant effect on phosphorus absorption when the amount of phosphorus in soil is low. One of the most important effects of Mycorrhizal fungi is increasing the yield of agricultural plants especially, in soils of low fertility. Such an increase may be due to the increase in the absorption of the roots Tarafdar and Marschner [28] showed that the increase in the percentage of mycorrhiza applied to the corn root had significant effect on the absorption of phosphorus, zinc and copper, while it has no significant effect on the absorption of Fe. George et al. [5] declared that root mycorrhizal symbiosis percentage had a negative correlation with the amount of phosphorus existing in the soil.

Materials And Methods

This experiment was carried out within 3 years 2008, 2009 and 2010 in the agricultural farm of Islamic Azad University / Takestan Branch in Ghazvin Province. The latitude of the region is northern 36.6 and eastern 49.39 of Iran Country and the altitude is 1325 m. According to kopen,s classification, the climate of this region is CSBS that is moderate climate with hot and dry summers. The mean rainfall is 250 mm and means temperature during the last five years has been 14 in the days. Rainfall is mainly during fall and winter. This experiment was performed in completely randomized blocks and as a split factorial design with four replications. The factors studied included: different amounts of irrigation including A1, A2, A3 of the main plots for 60, 120 and 180 mm evaporation respectively from the class A vapor basin, and different levels of pure phosphorus supplied from triple super phosphate source applied to different levels of P1, P2, P3, for 0, 60 and 120 kg/ha respectively. Nitrogen, phosphorus and potassium used from the source of urea 46%, super phosphate triple 46% and sulfate potassium 50%. Mycorrhiza fungi were combination of different species including Glomus mossea, Glomus intraradices, Glomus etunicatum with nearly equal spore population. mycorrhizal inoculums applied levels of inoculation (g), referring to without inoculation and inoculation. To prepare the plots, as it was customary in the region, the land was ploughed once and two discs were devised in the land in a vertical position. After clarification of the plan of the main and sub plots, various amounts of Phosphor fertilizer in addition to other macro and micro elements were weighed according to soil test (Table 1) and were mixed with the soil (Fe, Mn4O and Zn, Cu2 Okg/ha). Each subplot included five rows, and 8 m length each. The distance between each two rows was 70 cm. The corn seeds were planted at a distance of 20 cm on each row. Each plot included 6 subplots. To prevent water of different plots from being mixed, each main plot was made at distance from one another and in between by two water canals. The hybrid used was Jeta planted with a density of 71000 Plants per ha and the irrigation was performed steadily in the form of furrow and it continued until a date when the height of the bushes reached to 20 cm above the ground. Next the irrigation was performed based on the degree of vapor in the basin and according to the treatments. At the end of corn growth period, the seed yield and other attributes were assessed by randomly selected one square meter of each sub plot. Soil texture was determined using the hydrometric method [4]. Agro technical practice was done based on the conventional methods in the region. Iron, manganese, Zn, and Cu were used at 40 and 20 kg/ha. At the end of corn growth period, the seed yield and other attributes were assessed by randomly selecting one square meter of each sub plot. Soil texture was determined using the hydrometric method [4]. PH of a saturated paste, organic carbon (wet oxidation method), Nelson and Sommers [18], total nitrogen (Kjeldahl method) Nelson and Sommers, available phosphorus (sodium bicarbonate extraction method) Olsen [19], and potassium (flame photometer method, emission spectrophotometry) Knudsen et al.; iron and manganese (Dithyenetriaminepentaacetic acid (DTPA) method; Baker and Amachar using atomic absorption spectrometer, (Model Perkin Elmer, 3110) were also determined. The statistical analysis was performed through Mstatc and Excel Software.

Results:

Highest grain yield with 4883 kg/ha was in second level irrigation(A2), moderate level phosphorus with inoculation mycorrhizal (A2P2G2) treatment. Results showed that in moderate water stress, by using proper amount of chemical phosphorus and mycorrhizal inoculation can compensate decrease in grain yield. Mycorrhiza develops an extensive network of hypha in symbiosis of host plant. This can significantly enhance the absorbing capacity of the host plant roots. Also, it has been indicated that mycorrhiza effectively increased stress level [14,16]. Mycorrhiza can substantially enhance the uptake of different nutrients under different conditions because of their extensive network of hypha and production of different enzymes such as phosphatase, enhancing the solubility of nutrients including P and the less mobile micro-elements [15]. Mycorrhiza is able to enhance plant uptake which can contribute to the production of of energy in the plant. In addition, P can improve plant growth under stress by enhancing water and nutrient uptake [14,15], when conditions are unfavorable to plant growth, for example under high level of drought stress, the host plant may not be able to develop a symbiosis with AM fungi, as the plant prefer to spend its energy to alleviate the stress rather than developing a symbiosis with AM fungi (Miransari concentrations [11] and hence, alleviate the stress. Therefore in shortage of available water sources, using mycorrhizal inoculums and using less chemical fertilizer and water supply may be a proper method to produce more food with less expenditure in developing countries with low soil fertility and climates under arid and semi-arid. 2010). This is somehow similar to some of the effects of AM fungi on plant growth under stress as AM fungi with its great abilities of being able to enhance Al-Karaki GN, Al-Raddad A [1]. Effects of arbuscular plant growth under stress and in the presence of mycorrhizal fungi and drought stress on growth and nutrient pathogens [27]. Under drought stress, uptake of two wheat genotypes differing in drought AM fungi are able to decrease abscisic acid resistance. finally after economical analysis we find the best treatment is A2P60G with 1133 $ pure profit per hectare, because of less cost about irrigation and decreasing in chemical fertilizer costs in compare other treatments..

Discussion:

In this field experiment 3 different factors, irrigation regimes, 2 dosages of phosphoric fertilizers and mycorrhizal fungi have been studied. The latter is considered as a connecting ring between the plant and the soil. Among the above-mentioned factors the 3 regimes of irrigation are considered dominant factors, because in the dry areas of Iran, particularly of the Qazvin province, irrigation water is a problem, i.e. without that factor soil cultivation is impossible.

After summarizing the results of the 3 years' (2008-2010) field experiment on the basis of the average data of grain yield the economic effectiveness of the investigated factors and their combinations according to the treatments have been studied. This approach enabled us to expose the portion of the economic effectiveness of all the factors and to evaluate correctly the compensation of productive expenses done in each treatment (Table 1).

Corn is an important grain crop for Iran and the market value of 1kg corn is 0,43 USA dollars. In the table all the productive expenses invested in the field experiment are brought in an integrated way, which we thought suitable to present in the text in detail.The irrigation regime $A_{1,}$ which is the first control of the field experiment, at the same time may be considered a productive treatment, because here the largest quantity of water is consumed (irrigation once a week in the capacity of 900m^3), and the obtained yield is comparatively high. The price of the water consumed during the vegetation was 300$ and 30$ for the electrical water-pump (in total 330$). In the other irrigation regimes the same volume of water was used once in two weeks (A_2 - 165$) and once in three weeks (A_3 - 110$). (Ghorbanian 2013) In the material expenses of the experiment all the mineral macro- and micro fertilizers, pesticides are included. Thus, in the field experiment triple super phosphate and P_{60} kg/ha per active ingredient have been used, and the cost was 60$, in case of P_{120} kg/ha the cost was 120$. As a general background in the field experiment the following substances were used: $CuSO_4$ – 10 kg/ha – 6,25$, $FeSO_4$ – 20 kg/ha – 12,5$, $ZnSO_4$ – 40 kg/ha – 25$, carbamide $CO(NH_2)_2$ – 400 kg/ha - 150$, K_2SO_4 – 150 kg/ha – 90$, sulfur - 300 kg/ha – 50$ and pesticides - 50$. The total price of the above-mentioned substances is 433,8$. The price of the concentrate of mycorrhizal fungi was 30$, which has also been included into the sum of material expenses. The total sum of material expenses according to the treatments varied between 384-534$, the smallest sum (384$) of the expenses has been in the irrigation regimes, and the highest was in the treatments irrigation + P_{120} kg/ha + mycorrhizal fungi.

The expenses on mechanisms used in the field experiment were 145$, which includes the work of the combine, mechanical sprinkling, tractor tillage, cultivation, transportation of fertilizers and harvesting, etc. To this sum the price of 25 kg/ha of seeds has been added, which comprised 23$. In the article of wages the expenses on irrigation, fertilization and other jobs were included, which in the treatments of the experiment varied between 110-

220$. The sum of these expenses was the highest in the conditions of irrigation regime A_1.The data of Table 1 show that the total price of the yield obtained from 1 ha is rather low, and it varies between 1037$ (A_3+ P_{120}+G) and 2100$ (A_2+ P_{60}+G), which is explained by low yield of the corn crop and, on the other hand, low prices of that grain. The total production expenses are not very high, either; from 907$ (A_3+ P_{120}+G) to 1292$ (A_1+ P_{120}+G), the main expenses being the irrigation water and material expenses [7]. The highest chief profit has been obtained in the conditions of the irrigation regime A_2, both in the sole treatment and in the combined treatments with two dosages of phosphoric fertilizers and mycorrhizal fungi. From this point of view the intensive irrigation regime of A_1 and the combined treatments with it showed lower results, because here the price of the irrigation water is twice as much. As in the other figures, here, too, we have separated four different blocks, where it is possible to set apart the control treatment and to compare the results of the other treatments with it. This approach enables us in similar irrigation conditions to reveal the effectiveness of the applied two dosages of phosphorus and mycorrhyzal fungi separately, as well as the advantages of the combined application of the three factors. [7] The pure compensation of the expended 1 dollar is rather low (0,07 – 1,18$), which is the ratio of pure profit and total productive expenses. The profitability of the applied factors directly reflects the ratio of pure profit and productive expenses expressed in percents, which is also rather low. Summarizing the results of the economic effectiveness it may be stated that in the conditions of the irrigation regime A_3 the created water deficit has a negative influence also on the uptake of phosphoric fertilizers, as well as the colonization of mycorrhyzal fungi, which in these conditions are not able to perform their bio-ecological functions. [7]. As Iran belongs to arid and semi-arid areas, water is a vital issue in producing crops while using water in appropriate way causes the increase in production rate. Regarding to decrease in irrigation period from 1 week to 2 weeks, by symbiosis between mycorrhiza and corn leads to increase in irrigation efficiency. This increasing in period of irrigation cause, decreasing in all the production costs such as electrical cost of water motors and also by this decreasing in period of irrigation, decrease the weed density in result this causes less use of agriculture's machines such as less use of tractor for fertilizing and spraying herbicide, also by increasing in culture area and increases of yield production, finally potential of production increases [7].

Using mycorrhiza improvement absorption of micro and macro elements and such as phosphorus, this causes reduction in using chemical fertilizers. The researches indicate that soil and water contamination are caused by chemical fertilizer. Microorganism such as mycorriza can protect soil from contamination by decrease use of chemical fertilizers and so can protect soil from the rate erosion and soil structure by less use of chemical fertilizers and this can reduce all expense that farmers paid annually for buying the chemical fertilizers and also decrease machines costs (table 1) and for government this can reduce all expense have paid for fertilizer imports process. To sum up, organic and intensive farming follow by the reduction in fertilizers especially for crop plant that means quality and quantity growth in crops and producing healthy food are the main purposes for ecologists. Without doubt, the application of biological fertilizers, in addition to the positive effects on all characters of soil, it is fruitful economically, environmentally, and socially, and can be suitable replacement for chemical fertilizers. [7]

Consequently, with regard to extreme application of chemical fertilizers, in addition to increasing of production costs, there have been environmental problems. One important topic to investigate in academics and research institutes, is the application of these useful microorganisms in order to meet crop plants requirements, and in near future utilizing of microbial incubation inoculums in commercial scale is not inevitable. Therefore in shortage of available water sources, using mycorrhizal inoculums and using less chemical fertilizer and water supply may be a proper method to produce more food with less expenditure in developing countries with low soil fertility and climates under arid and semiarid.

Regard to cost table for planting until harvesting period of produce for corn (table 1) with less using of chemical fertilizer and increasing in period of irrigation instead of 1 week to 2 week also show in this research we can less expenditure produce for increasing in produce potential and proper method to produce more healthy food. Treatments a2p60G, a2p120G, a1p60G were in a statistical group and had higher grain yield than other treatments. If you consume and consume 60 kg of phosphorus Mycorrhiza fungus, 14-day irrigation and optimum performance is achieved, given the high cost of irrigation water and irrigation in 14 days, favorable treatment and diagnosis a2p60G is introduced. [7. Meanwhile, the 14-day application of irrigation and 120 kg of pure phosphorus is also the result of good performance, and given that consumption of high yield with 120 kg of phosphorus also had the net result is the best treatment based on the results of three years a2p60G introduced, In addition to irrigation, which consumes more than 14 days and less than 60 kg of phosphorus and irrigation water costs and reduced chemical fertilizer with phosphorus to the amount of 60 kg. Consequently, with regard to extreme application of chemical fertilizers, in addition to increasing of production costs, there have been environmental problems. One important topic to investigate in academics and research institutes, is the application of these useful microorganisms in order to meet crop plants requirements, and in near future utilizing of microbial incubation inoculums in commercial scale is not inevitable. Therefore in shortage of available water sources, using mycorrhizal inoculums and using less chemical fertilizer and water supply may be a proper method to produce more food with less expenditure in developing countries with low soil fertility and climates under arid and semiarid. [7].

Table 1: Economic effectiveness of application of different irrigation regimes, phosphoric fertilizers and mycorrhizal fungi in corn plantations (on the basis of 6 months' work and grain yield)

Treatments	Yield of corn grain, kg/ha	Cost of yield, $	Productive expenses, USA $/ha						pure profit, $	pure compensation of 1$ expenditure	Profitability
			Material expenses	Irrigation water	Exploitation of mechanisms+seed prices	Wages	Other expenses	Total			
1. A_1 – irrigation (1st control)	4660	2004	384	330	168	170	40	1092	912	0,84	83,5
2. A_2 – irrigation (2nd control)	4195	1804	384	165	168	110	30	827	977	1,18	118,1
3. A_3 – irrigation (3rd control)	2695	1159	384	110	163	90	20	767	392	0,51	51,1
4. A_1+P_{60}	4734	2036	444	330	168	220	40	1202	834	0,69	69,4
5. A_1+P_{120}	4437	1908	504	330	168	220	40	1262	646	0,51	51,2
6. A_2+P_{60}	4368	1878	444	165	168	160	30	967	911	0,94	94,2
7. A_2+ P_{120}	4260	1832	504	165	168	160	30	1027	805	0,78	78,4
8. A_3+P_{60}	2929	1259	444	110	163	140	20	877	382	0,44	43,6

continuation of Table 1

9. A_3+ P_{120}	2465	1060	504	110	163	140	20	937	123	0,13	13,1
10. A_1+G(mycorrhizal fungi)	4635	1993	414	330	168	220	40	1172	821	0,70	70,1
11. A_2+G	4586	1972	414	165	168	160	30	937	1035	1,10	110,5
12. A_3+G	2754	1184	414	110	163	140	20	847	337	0,40	39,8
13. A_1+P_{60}+G	4777	2054	474	330	168	220	40	1232	822	0,67	66,7
14. A_1+P_{120}+G	4487	1929	534	330	168	220	40	1292	637	0,49	49,3
15. A_2+P_{60}+G	4883	2100	474	165	168	160	30	967	1133	1,17	117,2
16. A_2+P_{120}+G	4752	2043	534	165	168	160	30	1057	986	0,93	93,3
17. A_3+P_{60}+G	2957	1272	474	110	163	140	20	907	365	0,40	40,2
18. A_3+ P_{120}+G	2412	1037	534	110	163	140	20	967	70	0,07	7,2

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