Proceedings

The Effect of Chemical and Biofertilizer on Grain Yield of Two Dill (*Anethum graveolens* L.) Cultivars †

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Abstract: In order to study the effect of combined fertilizer management of bio-fertilizer and chemical fertilizers on grain yield of two dill (*Anethum graveolens* L.) ecotypes, a field experiment was arranged in a factorial layout based on randomized complete block design with three replications in 2019 in Agricultural Research Farm of the University of Tabriz. The first factor includes two ecotype (C1: Native of Tabriz and C2: Varamin); while the second factor was composed of five fertilizers levels, namely control (N0), chemical fertilizers (N1), *Enterobacter cloacae* S16-3 bacteria + half a chemical fertilizer (N2), *Piriformospora indica* Fungi + half a chemical fertilizer (N3) and combination of bacteria + fungi + half a chemical fertilizers (N4). Although the highest yield and yield components were obtained for chemical fertilizers treatment (N1), but there was no statistically significant difference with the combined treatment (N4). The combined application of biofertilizers (growth-promoting bacteria and fungi) in addition to reducing chemical fertilizers (50%), led to high grain yield. Accordingly, the application of combined treatment (N4) can be a suitable treatment for the cultivation of medicinal plants, including dill.

Keywords: bio-fertilizer; chemical fertilizer; dill; *Enterobacter cloacae*; grain yield; *Piriformospora indica*

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1. Introduction

Many of the herbs and spices used by humans to season food yield useful medicinal compounds. The demand for medicinal plants is currently increasing in both developed and developing countries for various reasons. They are used in pharmacy, cosmetology, perfumes and the food industry among others (Padulosi et al. 2002).

Dill (*Anethum graveolens* L.) is an annual plant of Apiaceae family which is grown as an important medicinal plant among the world. Uses of dill seeds are carminative, stomachic and diuretic. It can also be used to increase milk production for mothers who breastfeed, helped prevent colic, bad breath, coughing, cold, flu and menstrual pains (Kerrouri et al. 2016). The treatment of potato tubers with carvone of the essential oil extracted from dill seeds led to the growth inhibition of the potato spouts (Sanli and Kardogan, 2019).

Bioferetilizer as essential components of organic farming, play a vital role in maintaining long term fertility and sustainability of soil (Mishra et al. 2013). Integrated nutrient management strategies involving chemical fertilizer and biofertilizer have been suggested enhancing sustainability of crop production. Rhizosphere associated nitrogen fixing bacteria have been used as inoculum for non-legume crop species (Mehnaz and Lazarovits, 2006).

This research was conducted out to study the effect of combined fertilizer management of biofertilizer and chemical fertilizer on grain production of two dill ecotypes at North West of Iran.

2. Materials and Methods

A field experiment was conducted out in a factorial layout based on randomized complete block design with three replications in 2019 in Agricultural Research Farm of the University of Tabriz which is located at North West of Iran (Longitude 46°17′ E, Latitude 38°05′ N, Altitude1360m above sea level).

The first factor includes two ecotype (C1: Native of Tabriz and C2: Varamin); while the second factor was composed of five fertilizers levels, namely control (N0), chemical fertilizers (N1), *Enterobacter cloacae* S16-3 bacteria + half a chemical fertilizer (N2), *Piriformospora indica* Fungi + half a chemical fertilizer (N3) and combination of bacteria + fungi + half a chemical fertilizers (N4).

Each plot consists of six rows with 25 cm distance from each other and 4m length. Bacteria and fungi used in this experiment as seed inoculums was provided at Soil Biology Laboratory of the Soil Sciences Department of the University of Tabriz.

At maturity stage, plants of 1 m^2 in the middle part of each plot were harvested and grain yield per unit area was recorded. Then above ground biomass was oven dried at 75°C for 48 h and weighed and subsequently plant biomass was calculated.

SPSS 9.4 software used to the data analyzed and the means of traits were compared using Duncan multiple range tests at $p \leq 0.05$.

3. Results

Analysis of variances showed significant effects of fertilizer type on biological yield, grain yield and harvest index of dill ecotypes. However, the ecotypes of dill had no significant differences in grain production (Table 1).

Table 1. Analysis of variances of the data for grain production traits of two dill ecotypes under chemical and biofertilizer treatments.

	Mean Squares		
Source of Variation	**Biological Yield**	**Grain Yield**	**Harvest Index**
Replication	496,175.09 **,1	55,729.4 ns	102.18 *
Ecotype	203,321.72 ns	37,619.07 ns	0.44 ns
Fertilizer	587,672.97 **	142,688.7 **	186.06 *
Replication * Ecotype	140,856.73 ns	23,443.9 ns	181.3 ns
Error	52,528.52	15,882,368	63.49
Cv(%)	15.25	22.82	21.49

[1], ns, *, **: No significant and significant at $p \leq 0.05$ and $p \leq 0.01$, respectively.

Biological yield of Tabriz ecotype was a little higher than Varamin ecotype, however the differences was not significant (Table 2).

Table 2. Mean comparison of grain production traits of two dill ecotypes under chemical and biofertilizer treatments.

Ecotype	Biological Yield g/m²	Grain Yield g/m²	Harvest Index %
Tabriz	1585.01a [1]	587.66a	37.19a
Varamin	142,036a	516.83a	36.95a

[1] Different letters indicate significant difference at $p \leq 0.05$ (Duncan test).

Dill biological yield increased significantly by application of fertilizers, the highest yield and yield components were obtained for chemical fertilizers treatment (N1), but there was no statistically significant difference with the combined treatment (N3, Fungi + half a chemical fertilizer andN4, combination of bacteria + fungi +half a chemical fertilizers) (Figure 1).

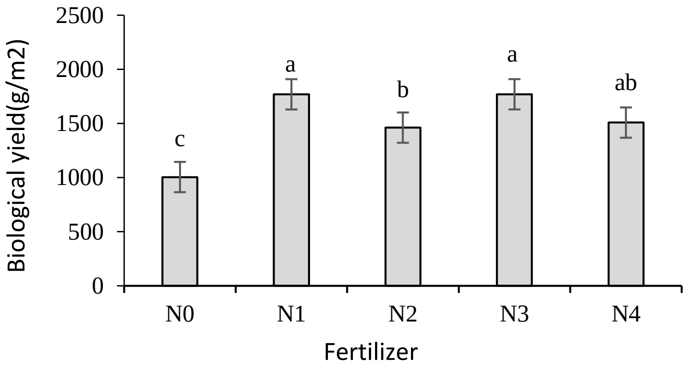

Figure 1. Dill biological yield affected by chemical and bio-fertilizer treatments. Different letters indicate significant difference at $p \leq 0.05$ (Duncan test). Control (N0), chemical fertilizers (N1), *Enterobacter cloacae* S16-3 bacteria + half a chemical fertilizer (N2), *Piriformospora indica* Fungi + half a chemical fertilizer (N3) and combination of bacteria + fungi + half a chemical fertilizers (N4).

The grain yield of dill ecotypes increased considerably by chemical and bio fertilizers, although the highest yield and yield components were obtained for chemical fertilizers treatment (N1), but there was no statistically significant difference with the combined treatment (N4 , combination of bacteria + fungi + half a chemical fertilizers) (Figure 2).

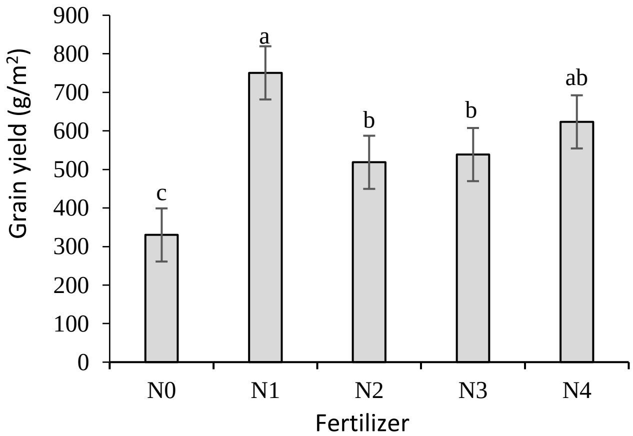

Figure 2. Changes in dill grain yield under chemical and bio-fertilizer treatments. Different letters indicate significant difference at $p \leq 0.05$ (Duncan test). Control (N0), chemical fertilizers (N1), *Enterobacter cloacae* S16-3 bacteria + half a chemical fertilizer (N2), *Piriformospora indica* Fungi + half a chemical fertilizer (N3) and combination of bacteria + fungi + half a chemical fertilizers (N4).

Harvest index of dill ecotypes also affected significantly by chemical and bio fertilizers, the highest harvest index was obtained from chemical fertilizers treatment (N1), but there was no statistically significant difference with the combined treatment (N4 , combination of bacteria + fungi + half a chemical fertilizers) (Figure 3).

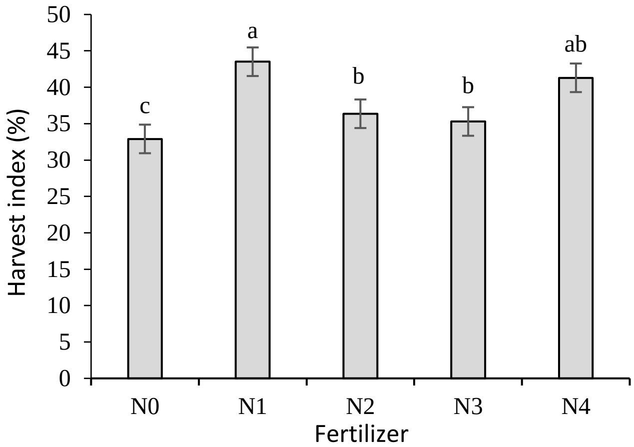

Figure 3. Harvest index of dill ecotypes affected by chemical and bio-fertilizer treatments. Different letters indicate significant difference at $p \leq 0.05$ (Duncan test). Control (N0), chemical fertilizers (N1), *Enterobacter cloacae* S16-3 bacteria + half a chemical fertilizer (N2), *Piriformospora indica* Fungi + half a chemical fertilizer (N3) and combination of bacteria + fungi + half a chemical fertilizers (N4).

4. Discussion

Dill ecotypes biological and grain yield increased significantly by chemical and bio fertilizers, our results shows that although *Enterobacter cloacae* the nitrogen fixing bacteria or *Piriformospora indica* Fungi could enhance the grain production of dill, however, the combination treatments of bacteria + fungi + half of chemical fertilizer had better performance (Figs. 1 and 2). Biological yield enhancement by plant growth promoting rhizobacteria (PGPR) and mycorhizal fungi reported by other researchers (Shaharona et al. 2006 and).

Optimizing in dill grain yield under integrated treatments could be related to increasing in photosynthesis and plant shoot growth improvement by soil microorganisms. It seems that application of mycorhizal fungi has symbiotic effect on dill grain production improving by nitrogen fixing bacteria. Accordingly, the application of combined treatment (N4) can be a suitable treatment for the cultivation of medicinal plants, including dill.

Institutional Review Board Statement:

Informed Consent Statement:

Data Availability Statement:

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