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RESEARCH ARTICLE

EFFECT OF PARENTAL NUTRIENT MANAGEMENT ON SEED GERMINABILITY OF TURNIP

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Abstract

To study the effects of fertilization of turnip (*Brassica rap* L.) plants with organic, biological, and chemical fertilizers on the produced seed germinability and seedling quality of turnip,a laboratory experimentwas conducted. First a field experiment was conducted with 15 different fertilizer treatments then produced seeds in each plot were used for laboratory experiment.The results showed that integration application of vermicompost, biological fertilizer and 25% of the required chemical fertilizer produced the best results in terms of seed germination percentage and seedling vigor. The quality of the seeds produced in this treatment was far higher than those produced in non-fertilized control plots or any other fertilization treatment. The results showed the combination of organic and biological fertilizers can lead to lowering the need of chemical fertilizers while improving the seed quality in turnip.

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Introduction:-

In arid and semi-arid areas, organic matter level of the soil is often very low (KeshavarzAfshar et al., 2015). Thus, conservation and improvement of the soil organic matter is crucial for maintaining soil health and sustainability of farming in these regions. Moreover, priority should be given to natural sources to provide plant required nutrients and enhance soil productivity in regard to improving sustainability. Successful crop production requires replacing adequate nutrients that have been removed by crops from the soil or lost to the environment one way or another. It is generally accepted that continuous application of chemical fertilizers may have negative impacts on soil health and environment (Yadav, 2003). Soil organic amendments and biological fertilizers, therefore, are considered as sustainable alternative sources of nutrients compared with synthesized fertilizers (Afshar et al., 2012).

Reports indicated that poultry manure alone or mixed with zeolite (which is called zeoponix) and vermicompost are amongst efficient soil organic amendments for crop production (Daryaei, et al., 2010; Afshar et al., 2014; Aranconet al., 2005). Zeolites are porous crystalline minerals that due to open pores and channels properties, has selective adsorption and certain ions can pass through and others can be absorbed (Mumpton, 1999). Because characters such as high cation exchange capacity, ammonium absorption and moisture absorption as well as helping to reduce wasting and leaching of nutrients, particularly nitrogen from the soil layers along with the other positive effects that has on soil physical properties, can be used as soil modifier in agriculture (Polat et. al., 2004). Zeolite has highpotential in absorption ofwater, ammonium, urea and ionic compounds and so on poultry is used as a substrate.After bird droppings absorbed by this material, zeolite become a nutritious combination that called

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Zeoponixand in addition to zeolite properties, it's rich in guano and can be used for soil fertility (Daryaei, et al., 2010).

Vermicompost is obtained through transformation and partial digestion of organic materials and residues by earthworms (Kale et. al. 1992). Vermicomposts containvarious enzymes such as protease, Lipase, Amylase,Cellulase, Lygnazand Chitinase, which have an effective role in biodegradation of organic materials. These organic fertilizers are also rich in vitamins, antibiotics and growth hormones (Zaller, 2007).

Bio-fertilizers or Plant Growth Promoting Rhizobacteria consists of one or more types of preservatives with a dense population of beneficial soil microbes, which are exploitedin order to supply nutrients required by plants, and/or control soil-borne disease and maintain structural stability (Vessey, 2003; Dadrasan et al., 2015). Although the use of bio-fertilizers for various reasons have fallen in the past few decades, but today according to problems that the indiscriminate use of chemical fertilizers has created, using them as a fundamental pillar of sustainable agricultural development has been reopened (Alexandratos, 2003).

Several trials have shown that using a combination of organic and chemical fertilizers can be much better than each of them acting alone applications and integrated use of these resources can not only mitigate the effects of malicious use of chemical fertilizers, but also guarantees sustainable crop production (Afshar et al., 2012). There is limited information available regarding the impact of parental nutrition supply on seed germination and quality. The aim of this study was to investigate the effect of different sources of fertilizers on the quality of the seeds produced by turnip (*Brassica rap* L.).

Materials and methods:-

Afield experiment was conducted at the Research Farm of the University of Tehran in Karaj, Iran (35.8400° N, 50.9391° E) in 2010-2011. The experiment was conducted in a randomized complete block design with 3 replications.Selected soil physical andchemical characteristics of the top 15 cm were as declared in Table 1. In this field experiment, fifteen fertilization treatments including: chemical, organic, biological, and their integration were studied as described in Table 2.Based on the soil test results, 150 kg N ha^{-1}, 75 kg P_2O_5 ha^{-1}, and 70 kg K_2O ha^{-1} were needed to supply turnip NPK requirement of turnip in this soil. Vermicompost used in this study was obtained from the Research and Experimental Farm of the College of Agriculture and Natural Resources, University of Tehran. Zeoponix was obtained from local Growers. Chemical composition of the vermicompost and zeoponix are presented in Table 3. Vermicompost and zeponix were applied at the rate of 5 t ha^{-1}. They were uniformly broadcasted on the soil surface then incorporated into 0-15 cm soil depth using a light disk. Biological fertilizer included ofa phosphate solubilizing bacteria (*Pseudomonas putida* strain 168) and a nitrogen-fixing bacteria (*Azotobacterchroococcum*), which were obtained from the Biology Department of Soil and Water Research Institute, Tehran, Iran. Seeds wereinoculated with biofertilizersaccording to the method of Somasegaran and Hoben(1994).

Table1:- Soil physical and chemical characteristics.

Soil Texture	pH	EC	OM	N	P	K	Fe	Zn	Mn	Cu
		dS/m	%	%	mg kg^{-1}					
Clay loam	8.2	1.6	0.7	0.08	19.8	200	7.2	0.7	18.6	1.6

Table 2:- Fertilizer treatments.

#	Treatment	#	Treatment
1	Control (CO)	9	Vermi +50%CF
2	Chemical fertilizer (CF)	10	Bio + 50%CF
3	Vermicompost (Vermi)	11	Vermi + Zeo + 25%CF
4	Zeolite (Zeo)	12	Vermi + Bio + 25%CF
5	Biological fertilizer (Bio)	13	Zeo + Bio + 25%CF
6	Vermi+ Zeo	14	Zeo + Ver + Bio
7	Vermi + Bio	15	Zeo + Bio
8	Zeolite +50%CF		

Table 3:- Vermicompost and Zeoponix physical and chemical characteristics.

Fertilizer	Fe	Zn	Mn	Cu	B		K	N	P	OC	pH	EC ds/m
	mg/kg						%					
Vermicompost	3258	112	283	55	-		118	2.3	75	26.9	8.3	7.2
Zeoponix	1249.2	216.8	521.2	67.55	33.4		2.04	2.7	1.3	-	-	-

Seeding was done on 10 Nov, 2010 and seed harvesting took place on 15 May, 2011.

Germination test:-

Germination tests were performed according to the methods of the International Seed Testing Association (ISTA, 1996). The experiment consisted ofa sample of 100 seed from each treatment,which were subdivided into four replications of 25 seeds each. Seeds were sterilized using 5% sodium hypochlorite for three minutes and then washed for 5 minutes (Javanmard et al., 2014). Seeds ofeach replication were placed in a 100 X 10 mm petri dish between two layers of filter papers. Ten ml of distilled water was added to each petri dishes. Then,petri dishes were placed in a plastic bag and kept under controlled temperature(25-16C day-night) until the end of the experiment (seven days), except for brief periods when the petri dishes were examined fordata collection. During these periods, seeds were exposed to fluorescent light and additional water was added frequently.

Petri dishes were evaluated on a daily basis and seeds were classified as germinated when the radicle had elongated to at least 2 mm. Abnormal seedlings (e.g., no radicle) were treated as non-viable.In addition to germination percentage, the following indices were also considered:

Mean time of germination (MTG): It is an indication of the speed and acceleration of germination which was calculated using the following formula(Ellis & Roberts, 1981):

$MTG=\sum NiDi/N$

WhereN isthe number of germinated seeds, I isthe number of day, Di isthe number of days from the starting test, and N istotal germinated seeds

Coefficient of velocity of germination (CVG): this shows the speed of germination calculated as follows (Jahanian et al., 2012):

$CVG = G1 + G2 + \ldots + Gn / (1 \times G1) + (2 \times G2) + \ldots + (n \times Gn)$

where G1 - Gn is number of germinated seeds all through the experimental period.

Mean of daily germination (MDG): which was calculated as follows(Jahanian et al., 2012):

$MDG = FGP/ D$

where FGP is final germination percentage and D is number of days from start to the end of the experiment.

Seedling vigor index (SVI): To measure SVI, shoot, radicle and seedling length, as well as shoot, radicle and seedling weight were measured at the end of the germination test. Then seedling vigor index was calculated as follows(Abdulbaki and Anderson, 1970):

SVI= (mean of shoot length + mean of radicle length) × total germination percentage

Statistical analysis

Analysis of variance (ANOVA) was conducted in SAS (7). Effects were considered significant at $P \leq 0.05$ by the F test, and when the F test was significant, Fisher's Least Significant Difference Test (LSD) was used for mean separations.

Results and Discussion:-

Results of the Analysis of Variance are shown in Table 4.

Seed germination:-

Turnip seed germination percentwas the highest (98%) when parental plants were treated withvermi+bio+25% CFfertilizer (Fig.1a). Final germination percentage in this treatment was significantly higher than that of non-fertilized control (88%). Application ofzeoponixalone or along with biological fertilizer resulted in a declined germination percent compared to the other treatments, including non-fertilized control.Mean time of germination was improved when parental plants were treated with Vermi + zeo treatment, showing that when parental plants received this treatment, the germination of their seeds was speeded up (Fig. 1b). However, faster germination process did not necessarily resulted in greater final germination percentage (Fig. 1a). Similar to the final germination percent, the CVGandMDG were the highest in the integration treatment of vermi+bio +25% CF (Fig. 1c and Fig. 1d). Similar to the other germination indices, application of zeoponix alone or in combination with biofertilizers showed negative impact on germination velocity.

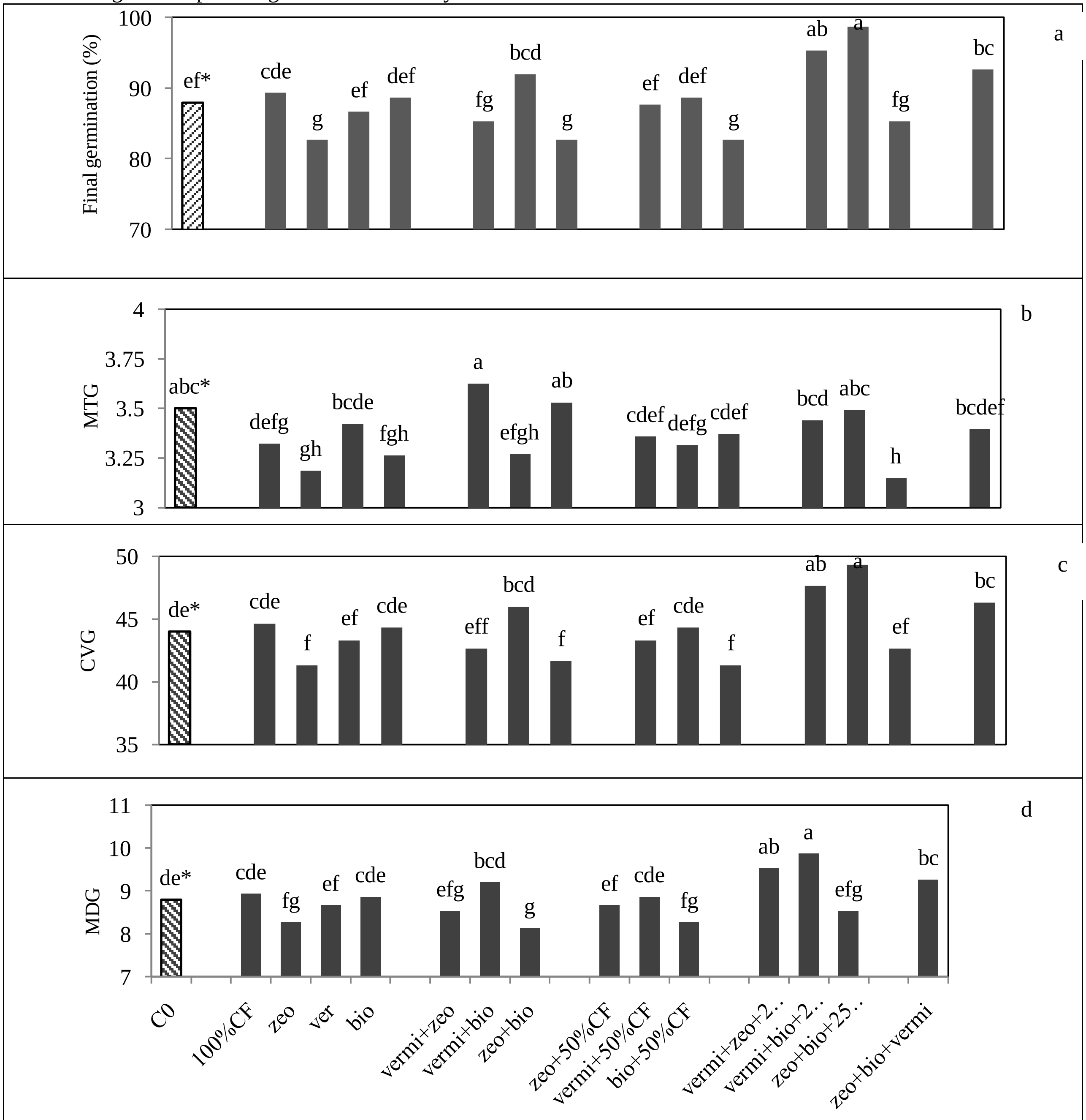

Fig 1:- Effect ofparental plant fertilization with organic, chemical, biological fertilizers and their combination on turnip seed germination percent (a), mean time of germination of MTG (b), coefficient of velocity of germination or CVG (c), and mean of daily germination or MDG (d).Means with the same letters are not significantly differences at P= 0.05.

Seedling Length and weight:-

As shown in Fig. 2, the highest seedling radicle length and seedling shoot length was observed in seeds that their parental plants were treated with vermi + bio+25% CF. This treatment enhanced seedling lengths notably, which was statistically significant. In fact, all fertilization treatment improved seedling length when compared to the non-treated control (Fig. 2c). So, by applying vermi + bio+25% CF on turnip plants, it can be expected that the produced seeds will have higher germination percentage with longer seedlings compared to the other treatments. However, the longer seedling could not be necessarily translated to heavier seedling as well. In contrast to seedling lengths, no significant difference was observed between fertilization treatment and non-fertilized control in terms of seedling weight, except of vermi treatment (Fig. 3a). In fact, the seedling weight was the highest in vermi treatment. Combining seedling length and weight together, the greatest seedling vigor was belonged to vermi + bio+25% CF, indicating that the seed in this treatment produced healthier and stronger seedlings compared to other treatments (Fig. 3b).

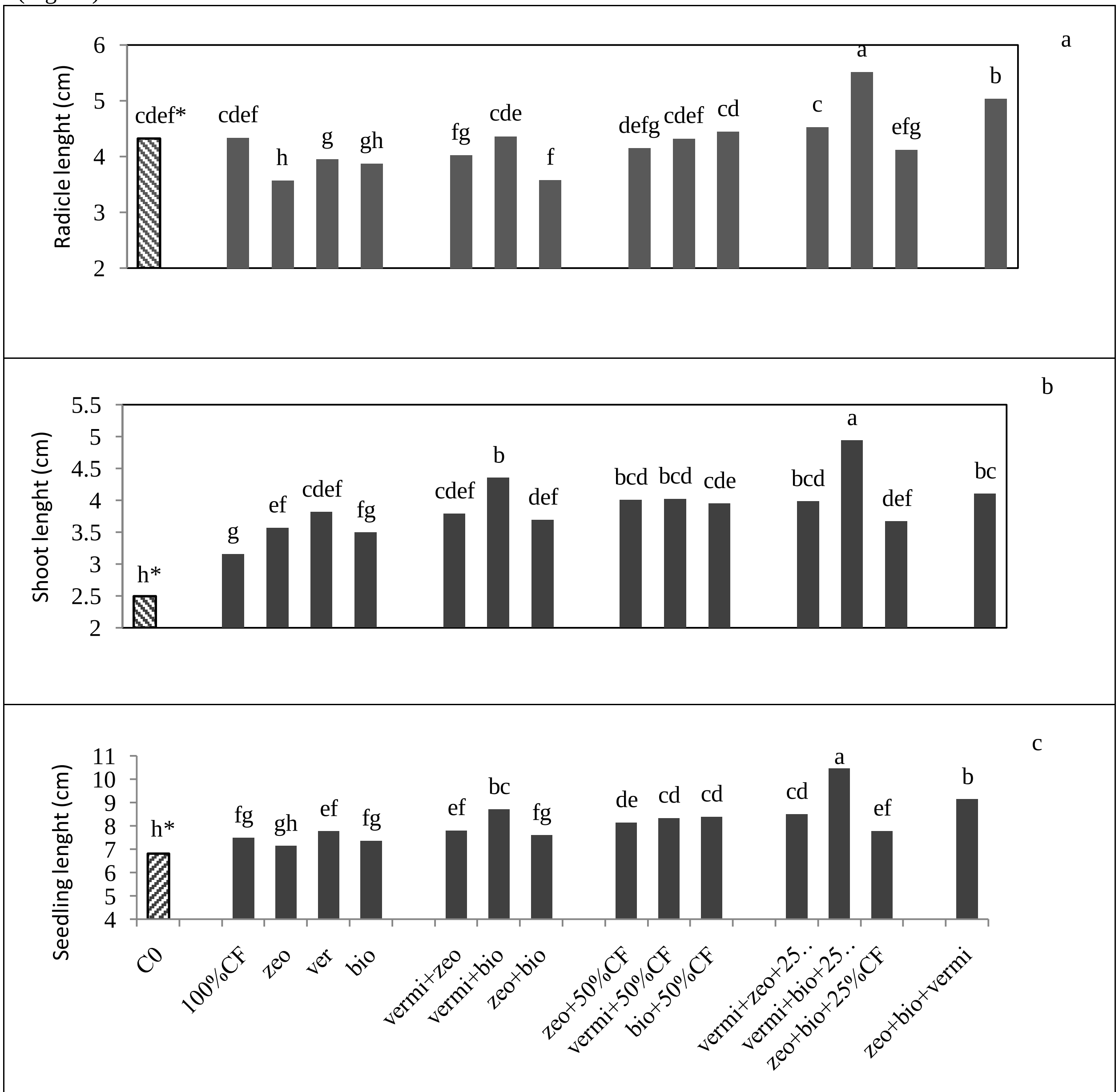

Fig 2:-Effect ofparental plant fertilization with organic, chemical, biological fertilizers and their combination on turnip radicle length (a), shoot length (b), and seedling length (c). Means with the same letters are not significantly differences at P= 0.05

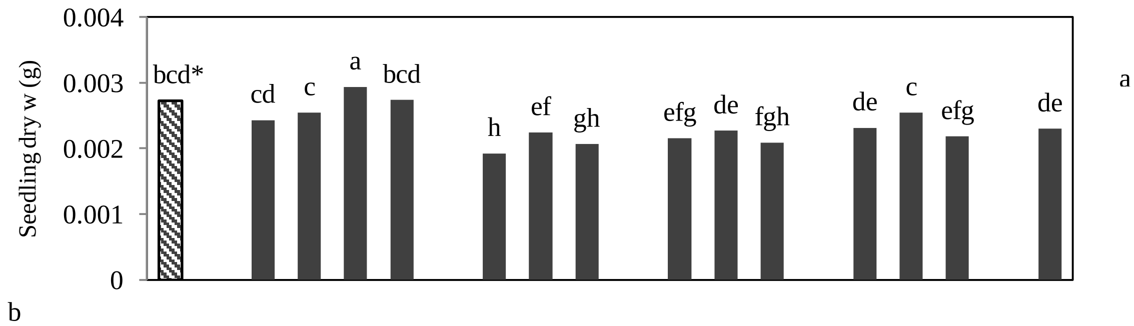

Fig 3:- Effect ofparental plant fertilization with organic, chemical, biological fertilizers and their combination on turnip seedling dry weight (a) and seedling vigor index or SVI (b).Means with the same letters are not significantly differences at P= 0.05.

Conclusion:-

The results indicated that treating turnip plants with vermi+bio+25% CF significantly improved the germination percentage of the seeds and seedling vigor in this crop. This suggests that theintegration oforganic fertilizer and biological fertilizers with a proportion of required chemical fertilizers will not only reduce the environmental hazards of the chemical fertilizers, but also can improve the seed quality in turnip.

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