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Effect of different sources of nitrogen and zinc sulfate on grain yield and its associated traits in marigold (*Calendula officinalis.* L)

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Abstract

In order to study the effect of nitrogen and zinc sources on grain yield and its associated traits of medicinal plants Marigold, an experiment was carried out based on factorial arrangements using randomized complete block design with three replications at the research farm of the Islamic Azad University, in Takestan province in 2010-2011 cropping season. The experimental factors included nitrogen sources (manure and inorganic) with 5 levels (0 tons farmyard manure +120 kg.ha^{-1} urea, 10 tons farmyard manure + 90 kg.ha^{-1} urea, 20 tons farmyard manure + 60 kg.ha^{-1} urea, 30 tons farmyard manure + 30 kg.ha^{-1} urea and 40 kg.ha^{-1} farmyard manure + urea and zinc sulfate with 3 level (with spraying, once spraying and twice spraying). The results showed that nitrogen fertilizer sources and zinc sulfate affect significantly on dry matter, the number of grains per head, and the number of heads per plants, weight grains and grain yield. Interaction effect between treatments affect significantly on the number of grains per head and the number grains per plant. The consumption 20 tons farmyard manure + 60 kg.ha^{-1} urea with twice spraying of zinc sulfate was more effective in improving yield and its components in marigold so that the maximum number of seeds per plant (1356 seeds), dry matter (1082 g.m^{-2}), and grain yield (269.1 g.m^{-2}) were obtained from treatment with 20 tons farmyard manure + 60 kg.ha^{-1} urea with twice spraying of zinc sulfate.

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Introduction

The use of medicinal plants for treat diseases is concurrent with human history (Lopes-Lutz *et al.,* 2008). Marigold (*Calendula officinalis* L.) is plant of citrus species, annual with yellow flowers that are native to the Mediterranean. The purpose of cultivating this plant is create drugs of effective ingredients in flowers and especially in the petals of flowers such as glucoside, mucilage, to copherol, carotenoids which are effective in the treatment of various diseases. Plants need to various nutrients for optimal growth and development, that the lack of these elements in soil is reduced plant growth and production (Saeidi, 2007), hence the nitrogen is most effective element in improving the quantitative and qualitative yield of plants. Several results reported about the impact of this element on various plants such as *Nigella Sativa* by Razvay Moghadam *et al.,* (2012), *Chamaemelumnobile* by Rahmati *et al.,* (2009), *German chamomile* by Sharafi *et al.,* (2011), *Valerian officinalis* L by Hormoz (2005), *Anethumgraveolensdhi* by Rassam *et al.,* (2006), *Menthapiperita* by Zeynali (2007) that indicated significant effect of nitrogen on yield, its components and the effective ingredient of these plants. In the experiment of Lotfi (2008), applying 100 $kg.ha^{-1}$ nitrogen, cause to achieve maximum height, number of branches, number of flowers, seed weight and yield in Polypropylene. In conducted study by Ehteramian *et al.,* (2002) use of 30 $kg.ha^{-1}$ N is recommended for achieve to maximum yield of cumin plant. Plant growth in addition to macronutrients also depends to micronutrients. Continuous cultivation, calcareous soils and lack of fertilizers containing needed nutrients, including causes of zinc deficiency in most soils in Iran. Zinc is absorbed as bivalent cations (Zn^{+2}), which contributes to the formation of indoleacetic acid that regulates plant growth, because Zinc in the plan not capable of remobilization. So spraying is a good way to security the needs of the plant (Bagheri-Kholenjanim, 2010). Rastegar and Shamsi-Mahmoud abadi (2010) stated that spraying zinc had significant effect on the number of umbels per cumin plant. Rahimi *et al.,* (2009) in research on *Coriandrum sativum* stated that use of zinc sulfate fertilizer increases umbels, seed weight relative to treatment. Given the importance and increasing need of marigold due to multiple drug uses, the present study were performed for examines the effect of spraying Zinc and compares sources of nitrogen fertilizer on grain yield of marigold plant and some other traits.

Materials and methods

In order to study the effect of nitrogen and zinc sources on grain yield and its associated traits of medicinal plants Marigold, an experiment was carried out based on factorial arrangements using randomized complete block design with three replications at the research farm of the Islamic Azad University, in Takestan province in 2010-2011 cropping season. The experimental factors included nitrogen sources (manure and inorganic) with 5 levels (0 tons farmyard manure +120 $kg.ha^{-1}$ urea, 10 tons farmyard manure + 90 $kg.ha^{-1}$ urea, 20 tons farmyard manure + 60 $kg.ha^{-1}$ urea, 30 tons farmyard manure + 30 $kg.ha^{-1}$ urea and 40kg farmyard manure + urea and zinc sulfate with 3 level (with spraying, once spraying and twice spraying). Plant density was obtained about 6$plants.m^{-2}$. Properties of the soil in the studied region are shown in Table 1.

The texture soil was found Sandy Loam. Considering the analysis of manure, the content of nitrogen in the fertilizer were determined about 2.87%. Zinc sulfate fertilizer with purity 35%was used at a rate of 5 $kg.ha^{-1}$ in 1000 liters water. Manure and half of urea after the first irrigation and before the second irrigation was added to the ground. Spraying of zinc sulfate was performed after two weeks from the first fertilization (2/20/2011). After the second sampling (4/20/2011), the residual urea fertilizer was added to farm, then spraying of zinc sulfate was done at third level (twice sprayings).

Crop sampling and calculation

Sampling was performed from 2 rows in the middle of each plot. After drying samples, operation weighing was performed by using of a detailed micro balance instrument. Then average of dry matter, the number

of grains per head, and the number of heads per plants, weight grains and grain yield was calculated.

Statistical analysis

Data analysis was done by using SAS and MSTATC software. The ANOVA test was used to determine significant ($p \leq 0.05$) treatment effect and Duncan Multiple Range Test to determine significant difference between individual means.

Results and discussion

The results of variance analysis showed that the sources of nitrogen and zinc sulfate had significant effects on dry matter, number of heads, number of seeds per head, seed number per plants, grain weight and grain weight and grain yield (Table 3).Interactive effects of nitrogen and zinc resources was significant on seed number per plant and seeds per head (Table 3).

Table 1. Chemical and physical characteristics: from zero to 30cm soil depth of field.

Sand	Silt	Clay	O.C	T.N.V	Zinc	Potassium	Phosphorus	Total N	pH	EC
			(%)				(ppm)			($ds.m^{-1}$)
52	30	18	0.64	3	0.7	380	9	0.06	7.7	0.9

Heads per plant

With comparing nitrogen levels in terms of heads per plant showed that use of 20 tons FYM+ 60 $kg.ha^{-1}$ urea cause increased 22% this property compared to consumption of only urea fertilizer. Naghdibadi *et al.,* (2002), and Rahmani *et al.,* (2009) reported improvement of vegetative growth and the number of heads in marigold in response to nitrogen fertilizer. Increase of nitrogen consumption by improved of growth caused to increase photosynthetic productions and thereby increase the number of lateral branches, so the maximum number of heads per plant was obtained with high amounts of nitrogen. Comparison of the consumptive levels of zinc revealed that with twice spraying zinc sulfate achieved the largest number of heads per plant 40.1, that 11% increased with compared to non-spraying (Table 4). Due to soil conditions and limitations of absorption on the soil appears increasing use of fertilizer be effective in development of reproduction of plant. Bagheri-Kholenjani (2010) showed that zinc sulfate fertilizer had significant effect on the number of safflower. This seems to suggest that zinc with synthesis of pollen tube protein leading to pollination, the formation of heads and more seeds.

Table 2. Analysis of variance of traits Study of Marigold plants.

S.O.V	d.f	Dry Matter	Head per plant	Grain per head	Grain per plant	1000- grain weight	Grain yield
Replication	2	14.00 ^{ns}	12.41^{ns}	25.45*	114470*	0.39 ^{ns}	1858 ^{ns}
Nitrogen source	4	47260**	97.45**	33.28**	18430 **	28.9 **	4664 *
Zinc	2	62290**	73.22*	37.38**	218265**	14.1 **	5961 *
Nitrogen source*Zinc	8	4850 ^{ns}	13.43^{ns}	12.08*	58545 *	1.8 ^{ns}	490 ^{ns}
Residual	28	2526	19.30	4.86	21639	2.43	1391
CV (%)	-	5.00	11.42	10.00	16.52	12.34	12.47

Ns, *and **: non significant, Significant at 5% and 1% probability levels, respectively.

Grain per head

Comparison of the interaction level of treatments of number of grain showed that consumption of 20 tons FYM+ 60 $kg.ha^{-1}$ urea with twice spraying zinc sulfate caused was achieved the greatest amount 63.26 of grains per head. With once spraying zinc

obtained the maximum number of seed in per head with use of 30 tons FYM + 30 kg.ha^{-1} urea with a 5.23 values, which with other levels of nitrogen except use of inorganic nitrogen sources were in similar groups.

In confirmation of this results, Rahmani *et al.,* (2007) showed that the highest number head of marigold achieved in terms of Favorable irrigation with 90 kg.ha^{-1} nitrogen. In study of Yadav *et al.,* (2002) on Plant agopsyllium determined that combination of the Chemical fertilizer with manure significantly increased the number of grains per spike.

Table 3. Comparison of simple and interaction effects of treatments on dry matter, number of heads per plant and number of grains per head.

Nitrogen source		Zinc Sulfate	Dry matter (g.m^{-2})	Number of heads per plant	number of grains per head
Urea Fertilizer (kg.ha^{-1})	Manure (kg.ha^{-1})				
0	120		906.5 c	34.20 c	19.53 b
10	90)		957.4 c	35.77 bc	23.08 a
20	60		1082.8 a	41.91 a	23.40 a
30	30		1057.1 ab	40.46 a	23.71 a
40	0		1021.6 b	39.89 ab	20.37 b
		non-use	942.9 c	35.94 b	20.38 b
		1 time spray	1000.8 b	39.30 ab	22.14 a
		2 time spray	1071.6 a	40.10 a	23.53 a
0	120	non-use	850.9	33.57	17.23 h
10	90		901.9	31.79	20.37 c-h
20	60		976.3	37.68	20.68 c-g
30	30		1003.2	37.37	22.25 b-e
40	0		982.3	39.27	21.38 b-h
0	120	1 time spray	910.3	33.53	19.11 d-g
10	90		937.7	36.34	23.50 a-c
20	60		1048.8	42.12	22.87 a-d
30	30		1066.3	42.90	23.50 a-c
40	0		1040.7	41.59	21.71 b-g
0	120	2 time spray	958.3	35.49	22.25b-e
10	90		1032.6	39.18	25.38 ab
20	60		1223.3	45.92	26.63 a
30	30		1101.8	41.10	25.38 ab
40	0		1042.0	38.81	18.02 efg

Means within a column followed by the same letter(s) are not significantly different based on Duncan's Multiple Range Test.

Grain per plant

The number of grains in per plant is affected the number of grains in head and the number of heads in plant. Maximum grains in plant were obtained with use 20 tons FYM+ 60 kg.ha^{-1} nitrogen and twice spraying zinc sulfate. Under without spraying zinc condition different nitrogen sources do not had effect on this trait. But under once spraying zinc sulfate conditions, increased consumption of manure and reduce urea consumption resulted increase grains in plant. In condition without spraying zinc and once spraying zinc, the maximum and minimum value for this trait achieved in combination treatment with 40 tons FYM+ 0 kg.ha^{-1} nitrogen and 120 kg.ha^{-1} nitrogen, respectively. Sharma and Pasard (1990) reported feeding of plant with zinc, due to increased hydrocarbon reservoir of pollen, caused increases longevity of pollen and consequently led to increased seeds number and pollination.

1000- grain weight

Comparison of the 1000-grain weight in nitrogen consuming levels showed that plants with consumption of 20 tons of manure +60 kg.ha^{-1} urea with generate grain weight 1.14 g were higher than others, so that the proportion of inorganic fertilizer

use alone 42% has increased . Rahmani *et al.,* (2009) stated that the highest seed weight of marigold plant with 6.12 g from the application of 90 kg.ha^{-1} nitrogen was obtained. Pouryousef *et al.,* (2007) expressed that fertility treatments, was significantly increases *Plantagopsyllium*gra in weight compared to normal treatments.Manure can be effective on root growth, proper supply of nutrients, increased leaf area and improve photosynthesis and the better sharing of the materials in grains. Moradi (2009) reported that release of nutrients slowly increases the amount of plant available water and improves soil structure with use of organic fertilizer, increases the speed and duration of photosynthesis and thereby increases grain weight of the *Foeniculumvulgare*. Comparing of zinc sulfate levels showed that twice spraying of zinc is achieved highest grain weight with value of 6.13g compared to non-spraying condition. Rastegarand and Shamsi-Mahmoudabadi (2010) stated that zinc sulfate had significant effect on *Cuminumcyminum* grain weight. Bagheri-Kholenjani (2010) reported that sprayingof zinc increases 35 percent of *Carthamustinctorius* grain weight.

Table 4. Comparison of simple and interaction effects of treatments on the number of seeds per plant, seed weight and seed yield.

Nitrogen source		Zinc Sulfate	number of grains per plant	1000-grain weight (g)	Grain yield (g.m^{-2})
Urea Fertilizer (kg.ha^{-1})	Manure (kg.ha^{-1})				
0	120		669.1 c	9.91 b	222.2 c
10	90		832.7 b	11.73 b	236.3 bc
20	60		1032.1 a	14.13 a	269.2 a
30	30		946.1 ab	13.41 a	260.5 ab
40	0		970.6 ab	13.98 a	252.5 abc
		non-use	768.7 c	11.66 b	229.7 b
		1 time spray	891.9 b	12.64 ab	252.7 ab
		2 time spray	1009.9 a	13.60 a	261.8 a
0	120	non-use	578.7 c	8.73	214.9
10	90		650.0 c	10.67	219.4
20	60		774.5 bc	12.17	242.6
30	30		843.9 bc	12.60	235.4
40	0		996.3 b	14.13	236.4
0	120	1 time spray	639.9 c	10.13	225.0
10	90		853.9 bc	11.63	241.0
20	60		965.3 b	14.00	267.1
30	30		943.0 b	13.63	263.8
40	0		1057.1 a	13.80	266.8
0	120	2 time spray	788.8 bc	10.87	226.6
10	90		994.3 b	12.90	248.5
20	60		1356.5 a	16.23	297.8
30	30		1051.5 a	14.00	282.1
40	0		858.5 bc	14.00	254.3

Means within a column followed by the same letter(s) are not significantly different based on Duncan's Multiple Range Test.

Grain yield

On Comparing nitrogen sources, the highest grain yield achieved with use of 20 tons FYM + 60 kg.ha^{-1} urea to the value 1.269 g.m^{-2}, that compared to mineral nitrogen fertilizer, 21 percent increase showed (Table 5).

Rahmani (2007) on Marigold and Akbarinia *et al.,* (2004) on *Foeniculumvulgare* reported increase of seed yield in result of nitrogen application rate of 90 kg.ha^{-1}. Kochaki and Sabet-Teimor (2010) stated that a positive response of *Hyssopusofficinalis* to manure due to improve soil quality, development of root growth and improvement of nutrient absorption of

water that outcome of this process is increasing grain yield. Comparing of zinc levels showed that twice spraying caused achieves highest grain yield with values 261.8 $g.m^{-2}$ that in compared to non-spraying treatment had increased 14%. RastegarandShamsi-Mahmoudabadi (2010) stated that the highest yield of marigold related to concentration of 6 ppm of zinc (492 $kg.ha^{-1}$). In recent study, zinc sulfate increases the number of grains in plant and consequently to increase yield.

Dry matter

Assessment of dry weight showed the highest dry matter was obtained with use 20 tons FYM + 60 $kg.ha^{-1}$ urea to amounts 1082 $g.m^{-2}$ that 19% increased compared to chemical nitrogen. Rahmani *et al.,* (2008) with comparing different doses of nitrogen fertilizer found that achieved the highest biological yield with use of 80 $kg.ha^{-1}$ N Marigold. Pouryousef *et al.,* (2007) expressed that manure application had increased dry matter of Plant agopsyllium to values 21%.manure with increase of humus and organic matter caused increase the physical characterizes of soil, so to create proper condition for expand roots of plants into soil, increase absorbing of water and nutrient in plant, in the result increases dry material. Comparing of zinc consumptive levels showed that with twice spraying zinc obtained highest dry material in amount 1071 per square that had increased 13% percent compared to without spraying zinc treatment (Table 5). Rahimi *et al.,* (2009) in a study about *Coriandrumsativum* plant stated that use of zinc sulfate caused increase the yield of plant branches and leafs. Bagheri-Kholenjani (2010) stated with increased consumption of zinc on marigold had improved 79% of biology yield.

Conclusion

The results showed that spraying of zinc can reduce nitrogen fertilizer application. Generally twice spraying of zinc sulfate, and use of 20 tons manure+ 60 $kg.ha^{-1}$ urea fertilizer had the greatest impact on improving yield and its components.

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