

Effects of Zeolite Application and Nitrogen Fertilization on Yield Components of Cowpea (*Vigna unguiculata* L.)

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Abstract: In order to examine the effect of zeolite application and nitrogen fertilization on yield and yield components of Cowpea, an experiment in factorial format based on randomized complete block design with three replications in Astaneh Ashrafiyeh Township (north of Iran) in 2011 was conducted. Factors of experiment was consist of two levels of zeolite (Z_1 : without zeolite application and Z_2 : zeolite application 5 t/ha) and six levels of nitrogen fertilization (N_1 : control (0 kg/ha pure nitrogen + without inoculation), N_2 : 30 kg/ha pure nitrogen, N_3 : 60 kg/ha pure nitrogen, N_4 : nitroxin inoculation, N_5 : 15 kg/ha pure nitrogen + nitroxin inoculation, N_6 : 30 kg/ha pure nitrogen + nitroxin inoculation). In mature time, seed yield, number of pod per plant, number of seed per plant, plant height, pod length and 100 seed weight were measured. Results showed that, the effect of zeolite application and also nitrogen fertilization on all measured traits had significant differences in 1% probability level but interaction effect of zeolite and nitrogen fertilization only on seed yield and plant height showed significant differences in 5% probability level and on other studied traits was non significant. Among zeolite application treatments Z_2 level with 835.8 kg/ha was recorded highest seed yield. Between nitrogen fertilization levels the highest seed yield was obtained from N_3 treatment. The maximum seed yield between interaction levels was found from Z_2N_3 treatment with 1224 kg/ha.

Key words: Cowpea • Zeolite • Nitrogen • Astaneh Ashrafiyeh • Iran

INTRODUCTION

Cowpea (*Vigna unguiculata* spp. *sinensis*) is one of the legume plants that grown in tropical and semi tropical countries specifically in Asian, African and South American countries, for important source of nutrients[1]. Zeolite minerals are hydrated aluminosilicates of alkali or alkaline-earth metals, structured in a three dimensional rigid crystalline network, formed by tetrahedral AlO_4 and SiO_4 , whose rings join in a system of canals, cavities and pores. These minerals are characterized by the ease of retaining and releasing water and exchanging cations without structural changes [2, 3] and can potentially be used in field or substrate cultivation [4]. There are over 40 species of natural zeolites, of which clinoptilolite is apparently the most abundant, both in soils and in sediments [5].

Studies carried out in the last century proved that soil enrichment with natural zeolites contributes to the increase of productivity of various agricultural crops and

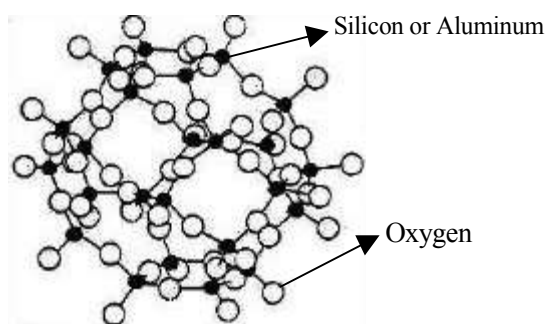


Fig. 1: Structure of zeolite

that simultaneously they are characterized by the aftereffect. That is, unlike mineral fertilizers, their annual application is not necessary, but positive effect of these minerals on enhancing plant productivity is manifested for several years [6,7]. Zeolites improve nutrient use efficiency by increasing P availability from phosphate rocks, improving the use of NH_4^+ -N and NO_3^- -N, reducing leaching losses of exchangeable cations, especially K^+

and also acting as slow-release fertilizer [8-13]. According to Leggo [14], due to the high affinity of zeolites for nutrients, these minerals may be used in growth media to improve plant yields. Mixtures of zeolite and fertilizers also had positive effects on lettuce [15] and tomato yields [16]. In addition, zeolites improve efficiency of water use, by increasing soil water holding capacity and water availability to plants [17,18]. Nitrogen (N) is required by plants in comparatively larger amounts than other elements [19]. Deficiency of N generally results in a stunted growth and chlorotic leaves caused by poor assimilate formation that leads to premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with abundant dark green (high chlorophyll) tissues of soft consistency and relatively poor root growth. This increases the risk of lodging and reduces the plants resistance to harsh climatic conditions and to foliar diseases [20]. N fertilizer use has played a significant role in increase of crop yield [21]. Excessive application of chemical nitrogen fertilizers could result in a high soil nitrate concentration after crop harvest [22-24]. This situation can lead to an increase in the level of nitrate contamination of potable water, because nitrate remaining in the soil profile may leach to groundwater [25]. The best way to solve these problems is usage of biological nitrogen fixation. The utilization of biological nitrogen fixation method could decrease the use of the chemical nitrogen fertilizer (urea), prevent the depletion of soil organic matter and reduce environmental pollution to a considerable extent [26]. Several bacteria that are associated with the roots of crop plants could induce beneficial effects on their hosts and often are collectively referred to PGPR (Plant Growth Promoting Rhizobacteria) [27]. The biological fixation of the nitrogen produced by these organisms could constitute a significant and ecologically favorable contributin to soil fertility [28]. Nitroxin is a biologic nitrogen fertilizer that containing *Azospirillum* and *Azotobacter*. *Azospirillum* belongs to family *Spirilaceae*, heterotrophic and associative in nature. In addition to their nitrogen fixing ability of about 20-40 kg/ha, they also produce growth regulating

substances [29]. Although there are many species under the genus as *A. amazonense*, *A. halopraeferens*, *A. brasilense*, however, worldwide distribution and benefits of inoculation have been mainly proved by the *A. lipoferum*, *A. brasilense*, *Azotobacter* belonging to *Azotobacteriaceae* family, aerobic, free living and heterotrophic in nature. *Azotobacter* are present in neutral or alkaline soils and *A. chroococcum* is the most commonly occurring species in arable soils. *A. vinelandii*, *A. beijerinckii*, *A. insignis* and *A. macrocytogenes* are other reported species. The number of *Azotobacter* rarely exceeds of 10^4 to 10^5 g⁻¹ of soil due to lack of organic matter and presence of antagonistic microorganisms in soil [30]. A bacterium produces anti-fungal antibiotics which inhibit the growth of several pathogenic fungi at the root zone, thereby, preventing seedling mortality to a certain extent [31].

MATERIALS AND METHODS

In order to study the effect of zeolite application and nitrogen fertilization on yield and yield components of Cowpea, an experiment in factorial format based on randomized complete block design with three replications in Astaneh Ashrafiyeh Township located in 37° 16' latitude and 49° 56' longitude (north of Iran) in 2011 was conducted. Soil analysis results show that (Table 1), the soil texture was Loam clay and pH 7.2. Factors of experiment was consist of two levels of zeolite (Z₁: without zeolite application and Z₂: zeolite application 5 t/ha) and six levels of nitrogen fertilization (N₁: control (0 kg/ha pure nitrogen + without inoculation), N₂: 30 kg/ha pure nitrogen, N₃: 60 kg/ha pure nitrogen, N₄: nitroxin inoculation, N₅: 15 kg/ha pure nitrogen+nitroxin inoculation, N₆: 30 kg/ha pure nitrogen + nitroxin inoculation). Measured traits were seed yield, number of pod per plant, number of seed per plant, plant height, pod length and 100 seed weight. The data was analyzed using MSTAT-C software. Also, the figures were drawing by EXCEL software. The Duncan's multiple range tests (DMRT) was used to compare the means at 5% of significant.

Table 1: the results of soil analysis at the experimental sites

Depth	0-30 cm	Soil texture	Loam clay
Clay (%)	46.58	E.C.(mmhos/cm)	1.32
Silt (%)	29.97	Total nitrogen (%)	0.194
Sand (%)	23.45	P (ppm)	9.1
pH	7.2	K (ppm)	197

Table 2: Analysis of variance related to the traits of cowpea under zeolite application and nitrogen fertilization

Source of variance	df	Seed yield (kg/ha)	No. of Po per plant	No. of Seed per plant	Plant height (cm)	Pod length (cm)	100 seed weight(g)
----- MS -----							
Zeolite (Z)	1	65195.111**	71.684**	14328.087**	184.733**	11.323**	9.923**
Nitrogen (N)	5	386750.644**	107.233**	19949.509**	315.859**	15.754**	5.615**
Z×N	5	8237.711*	1.508 ^{ns}	368.909 ^{ns}	28.505*	0.310 ^{ns}	0.103 ^{ns}
Error	22	2315.164	1.862	230.372	9.737	0.425	0.108

Ns, ** and * respectively: non significant, significant in 1% and 5% area

Table 3: mean comparison of the effects of zeolite application and nitrogen fertilization

Treatments	Seed yield (kg/ha)	No. of Pod per plant	No. of Seed per plant	Plant height (cm)	Pod length (cm)	100 seed weight(g)
Zeolite						
Z ₁	750.7b	37.4b	488.2b	61.1b	12.4b	9.2b
Z ₂	835.8a	40.2a	528.1a	65.7a	13.5a	10.3a
Nitrogen						
N ₁	463.7e	32.43e	407.4d	53.60d	10.96c	8.33e
N ₂	794.3c	38.65c	525.2b	64.78b	13.15 b	9.65c
N ₃	1129a	44.18a	568.8a	72.68a	14.88a	11.08a
N ₄	565d	35.88d	477.8c	58.56c	11.10c	9.16d
N ₅	793c	39.37c	526.5b	60.46c	13.12b	9.83c
N ₆	1015b	42.12b	543.5b	70.27a	14.36a	10.48b

Within each column, means followed by the same letter do not differ significantly at P<0.05

RESULTS AND DISCUSSION

Effect of Zeolite Application: With attention to variance analysis table (Table 2), the effect of zeolite application on all measured traits was significant at 1% probability level. Comparison of mean between zeolite application levels show that (Table 3), the highest amounts of Seed yield with 835.8 kg/ha, number of Pod per plant with 40.2 pods, number of seed per plant with 528.1 seeds, Plant height with 65.7 cm, Pod length with 13.5 cm and 100 seed weight with 10.3 g was obtained by zeolite application (Z₂). On the other hand the lowest seed yield, number of pod per plant, number of seed per plant, plant height, pod length and 100 seed weight respectively with 750.7 kg/ha, 37.4 pods, 488.2 seeds, 61.1 cm, 12.4 cm and 9.2 g was found from without application zeolite treatment (Z₁). Similar results about positive effect of zeolite on yield and yield components of crop were obtained by Valente *et al.* [16], Gül *et al.* [15], Polat *et al.* [32] and Harb and Mahmoud [33].

Effect of Nitrogen Fertilization: Results of variation analysis show that (Table 2), the effect of nitrogen fertilization on all studied traits had significant differences in 1% probability level. Comparison of mean between

nitrogen fertilization levels show that (Table 3), the highest seed yield with 1129 kg/ha, number of Pod per plant with 44.18 pods, number of seeds per plant with 568.8 seeds, plant height with 72.68 cm, pod length with 14.88 cm and 100 seed weight with 11.08 g was recorded from 60 kg/ha pure nitrogen application (n₃). The N₆ treatment (30 kg/ha pure nitrogen with nitroxin inoculation) with 70.27 cm plant height and 14.36 cm pod length statistically was placed in same level with N₃ treatment. The lowest seed yield, number of Pod per plant, number of seed per plant, Plant height, Pod length and 100 seed weight respectively with 463.7 kg/ha, 32.43 pods, 407.4 seeds, 53.60 cm, 10.96 cm and 8.33 g was recorded from n₁ treatment (without application of pure nitrogen and nitroxin inoculation). Similar results were reported by EL-Habbak and Naggat [34], Pizto *et al.* [35], Salah *et al.* [36] and Soheir and Mokhtar[37].

Interaction Effects: With attention to variance analysis table (Table 2), interaction effect of zeolite application and nitrogen fertilization on seed yield and plant height was significant in 5% probability level. But on other studied traits was non significant. With attention to figure 2 and 3, The highest seed yield with 1224 kg/ha and plant height with 79.27 cm was recorded from interaction level of Z₂N₃,

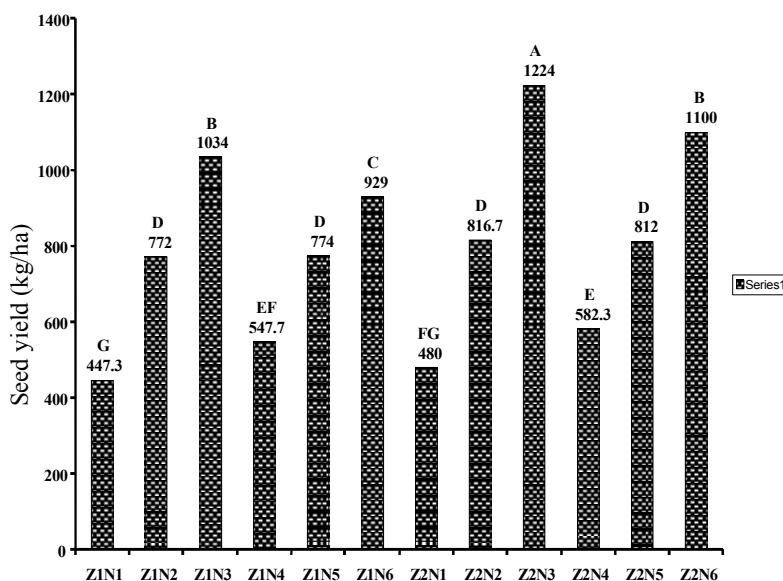


Fig. 2: Interaction effect of zeolite and nitrogen fertilization on seed yield

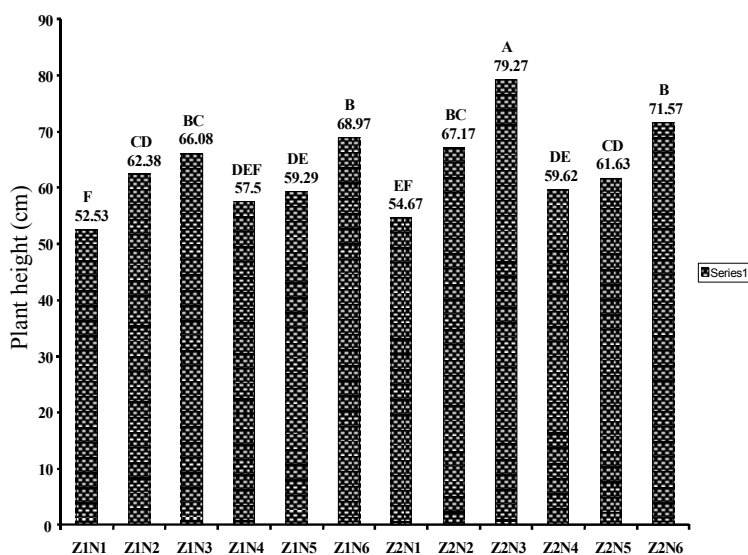


Fig. 3: Interaction effect of zeolite and nitrogen fertilization on plant height

(zeolite application along with 60 kg/ha pure nitrogen). On the other hand, the lowest seed yield 447.3 kg/ha and plant height with 52.53 cm was recorded from Z₁N₁ (without application of zeolite and without nitrogen fertilization) treatment (Figure 2 and 3). Similar results were reported by Gül *et al.* [15], Rehakova *et al.* [38] and Supapron and Ptayakon [39].

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