

The effects of different rates of super absorbent polymers and manure on corn nutrient uptake

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Abstract

In a field experiment, the simple and interactive impacts of super absorbent polymer (A200) and cow manure applications on macronutrients uptake (N, P, K, Ca, Mg) by corn were studied. The experiment utilized a randomized complete block design (RCBD) with six treatments and four replications. Treatments were applied based on application of 45 t/ha of cow manure and super absorbent polymer based on 200 kg/ha, including control (without using cow manure and super absorbent polymer), use of 100% manure (45 t/ha), use of 100% super absorbent polymer (200 kg/ha), application of 50% manure and 50% super absorbent polymer, addition of 35% manure and 65% super absorbent polymer, using 65% manure and 35% of super absorbent polymer to soil. The corn variety was SC 704. After harvesting, we prepared composite samples of the whole plants (seeds and plant residues) and N, P, K, Ca, and Mg concentration were measured. The obtained data were analysed by MSTATC software and means were compared by Duncan's test at 5% level. The results showed that application of 65% cow manure and 35% super absorbent polymer (26 t/ha cow manure + 70 kg/ha super absorbent polymer) increased grain yield by 16.2% compared with control. This treatment increased the uptake of N by 15.9%, K 17.6%, and Ca 14.7%. These increases were statistically significant at $P < 0.05$.

Key Words

Corn, super absorbent polymer, manure, nutrient uptake

Introduction

Iran is an arid region and crop production systems must adapt to this climate. Water is the main problem limiting yield improvement. In order to save soil moisture, some materials such as crop residue, mulch plants, waste, litter, straw and stubble, and other synthetic materials like Hydroplus, super absorbent polymers can be used. Super absorbent polymers are highly hydrophilic due to low cross-links in their structure and retain much water. Commercial corn varieties are important on Fars province's farms. The third most important crop after wheat and rice in the world is corn (Imam 1970). Super absorbent polymer is very expensive (12 to 15 US \$ per kg) and soils of Fars are poor in organic matter. We designed this research to improve the water holding capacity of soil.

Materials and methods

The effects of different levels of cow manure and super absorbent polymers on macronutrient uptake by corn were studied in an experimental field in Zarghan of Fars in southern Iran. The site is located at latitude of 52°-43'N and longitude of 49°-47'E and 1604 m height. The basic design was a randomized complete block design with four replications and six treatments. Factors were included application of different levels of cow manure and super absorbent polymer at six levels (based on addition of 40 t/ha of manure and super absorbent polymer based on addition 200 kg/ha (Imam 2005; Alahdadi *et al.* 2004).

Treatments were:

A1: control (without use manure and super absorbent polymer)

A2: application 100% manure (40 tons per hectare)

A3: application 100% super absorbent polymer (200 kg ha)

A4: application of 50% manure and 50% super absorbent polymer

A5: application of 35% manure and 65% super absorbent polymer

A6: application of 65% manure and 35% super absorbent polymer.

Table 1. Soil characteristics at the experimental site in Zarghan Fars in southern Iran.

Sand (%)	Silt (%)	Clay (%)	O.C (%)	TNV (%)	T. N (%)	pH	EC(dS/m)
49	28.5	22.5	1.10	41	0.95	8.43	0.68
P	K	Ca	Mg	Cu	Zn	Mn	Fe
mg/kg							
11.5	295	120	297	1.51	0.6	6.5	9.7

The EC of applied water was 750 $\mu\text{S}/\text{cm}$ (fresh water). The capacity of super absorbent polymer to absorption water was reported about 180 gram of water per 1 gram super absorbent polymer. The applied super absorbent polymer belonged to the type A200 products, of Nanoab e Iranian company (under license Polymer and Petrochemical of Iran). In total 24 experimental plots, including 4 rows with the width of 3m and the length of 10m. The distances between rows considered as 75 cm and distance between plants was 15 cm. Therefore, average plant density was 8.8/m². Based on soil analysis, 100 kg/ha ammonium phosphate and 350 kg/ha urea fertilizers were applied in all treatments. The manure and super absorbent polymer were mixed completely with the soil of plots. Then, seed planting was carried out. The variety of corn was SC 704. Harvesting was done in late September after the completion of corn growing period and after the maturity (black layer formed by seed). Ten plants were taken from the middle of each 4.5 m² plot to measure the performance level. Grains and the residues were weighted and then, completely mixed and the samples were analysed in the Soil Science Laboratory of Khakazma Company in Shiraz Iran for macronutrients (N, P, K, Ca, and Mg). The obtained data were analysed by MSTATC software and the means compared by Duncan's test at 5% statistical level and the graphs were drawn by Excel program.

Results

The ANOVA result is shown in Table 1. According to this Table, we can see the amounts of K, N and Ca uptake are significantly different at 5% level but Mg and P uptakes are not significantly different.

Table 2. Summary analysis of variance of macronutrients uptake by corn.

S.O.V.	M.S	F value	C.V. (%)
P	78	2129 ns	11.4
K	874	2195*	9.0
N	985	2533*	6.1
Ca	616	5616*	10.4
Mg	559	2202 ns	6.8

*, ** and ns, mean significant at level of 1%, 5% are not statistically significant

Potassium absorption in treatment A5 and A6 respectively increased 21% and 17.6% compared to control (Figure 1). The treatments that contain cow manure increased K uptake because cow manure contains large amounts of K. The largest amounts of K uptake are due to treatment A6 that contain sufficient organic matter and moisture in the presence of super-absorbent polymer. Livestock waste potassium through the soil forage harvest is returned to the soil. Return of livestock waste as a fertilizer to provide soil potassium is a fundamental cycle (Kocheki *et al.* 1998). A4 and A6 treatments provided 15.9 % and 5.7 % increases as compared to the control for nitrogen absorbed (Figure 2).

In 2004 in the Education and Research Centre, University of Florida Citrus Research America by using sodium poly acrylic (PAM) and potassium poly acrylic (AGRO) and the seedling of citrus to evaluate their effect on the growth and nitrogen uptake by plants and they performed effectively. The results showed that the polymer (PAM) slightly increased the amount of nitrogen in the soil but has no impact on plant growth. Nitrogen absorption from increased. Polymer (AGRO) clearly improved seedling growth and increased absorption of nitrogen and nitrogen wasted through leaching of saline soils was reduced (Martinez *et al.* 2004). Yazdani *et al.* (2008) studied the influence of super absorbent polymer and water stress on the qualitative and quantitative performance of soybean seed protein. They showed that the beneficial influence.

Applied treatments A2, A5 and A6 increased calcium absorption, respectively, 16.1 % and 14.6 % and 14.7 % compared to controls (Figure 3). Increased manure had an effect and super absorbent polymer alone had little effect. The difference was not statistically significant and the total harvest for A5 and A6 treatment ws due to organic matter and moisture together. Press *et al.* (1996) reported that addition of compost to the soil increased the uptake of phosphorus, potassium, calcium, zinc and manganese.

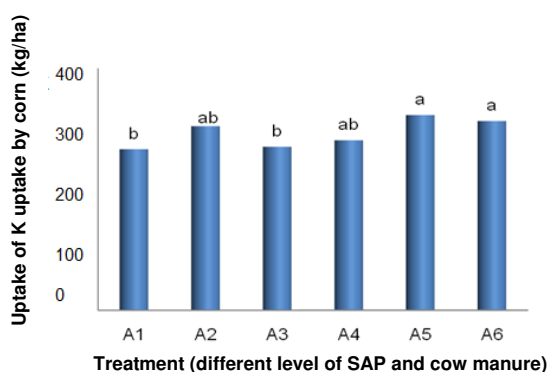


Figure 1. Average total uptake of potassium in corn.

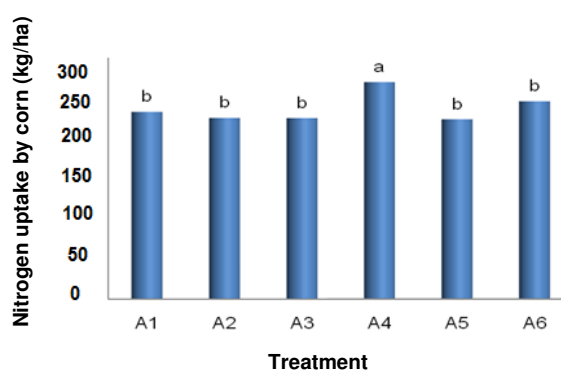


Figure 2. Average total nitrogen uptake by corn.

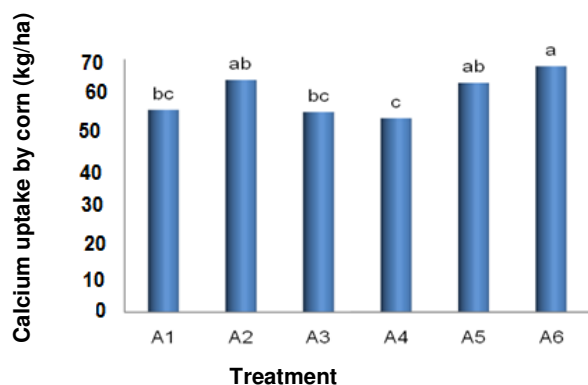


Figure 3. Average total calcium uptake by corn.

Conclusion

Cow manure increased absorption of potassium and phosphate. Super absorbent polymer increased absorption of potassium phosphorus and nitrogen. The combined effects of cow manure and super absorbent polymer increased nutrient uptake, CEC, and soil moisture supply. Maximum absorption was for treatment A6 which increased yield by 16.2 % and macronutrient uptake by 9.6 % in corn. This treatment consisted of 70 kg super absorbent polymer and 26 t/ha cow manure.

Suggestions

This test should be repeated under different conditions. Better result might be expected with more experiments with organic fertilizers such as compost. Considering the benefits highlighted here, these compounds show promise for use in gardens.

References

- Alahdadi A, Moazen B, Gamsari. Gh. Akbari, Zohorian Mehr (2006) 'Influence of different amounts of super absorbent polymer A200 different level of irrigation water on growth performance and economical yield. third training seminar and specialized agricultural use Hydrigel super absorbent'. (Tehran. Polymer and Petrochemical Institute).
- Araji AA, Abdul ZO, Joyce P (2001) Efficient use of animal manure on cropland-economic analysis. *Bioresource Technology* **79**, 179191.
- Imam Y (1970) 'Grain Agronomy'. (Shiraz University Press)
- Kochehi EE, Nakhforosh VH, Zarif K (1998) 'Organic Farming'. (Ferdowsi University of Mashhad Press).
- Martinez FX, Contreras F, Lopez N (2004) Influence of polyacrylamide on physical properties of a pet-perlite mix and on the growth of argynthemum coronopifollium. *ISHS Acta Horticulture* **554**, Press CM (1996) organic by product effect on soil chemical properties and microbial communities. *Compost Sci: Util.* **4**, 70-80.
- Yazdani F, Alahdadi A, Akbari, Behbahani MR (2008)' Effect of Super absorbent polymer (Terawatt A200) and different levels of drought stress on soybean yield and yield components'. Research in agriculture and horticulture and construction. No. 75.