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DOI: 10.2478/cerce-2019-0015
Available online: www.uaiasi.ro/CERCET_AGROMOLD/
Print ISSN 0379-5837; Electronic ISSN 2067-1865

Original Article

Cercetări Agronomice în Moldova
Vol. LII , No. 2 (178) / 2019: 151-157

THE IMPACT OF SOIL AMENDMENT OF SUPER ABSORBENT POLYMER ON GRAIN YIELD AND YIELD COMPONENTS OF CORN IN CENTER OF IRAN

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Received: Feb. 04, 2019. Revised: July 17, 2019. Accepted: July 31, 2019. Published online: Oct. 18, 2019

ABSTRACT. Corn is one of the most important cereal crop grown in Iran. A complete randomized design with four replications was used to analysis the influence of soil amendment of super absorbent polymer on grain yield and yield components of corn in center of Iran in 2016 and 2017. Treatments with super absorbent polymer were 0 kg/ha (S1), 15 kg/ha (S2), 30 kg/ha (S3), and treatments with fertilizers were 50% (F1), 75% (F2), 100% (F3), which could be combined into nine pots. The influence of super absorbent polymer was significant on spike weight in 2017, above-ground biomass in 2016, one hundred seed weight in 2016, and grain yield in 2017. There was no meaningful influence of super absorbent polymer on spike weight in 2016, above-ground biomass in 2017, 100 seed weight in 2017 and grain yield in 2016. Fertilizer treatments had significant influence on spike weight, above-ground biomass, 100 seed weight, and grain yield in both 2016 and 2017. The interaction between SAP and fertilizers had significant effect on above ground biomass in 2017. In both years, the highest spike weight, above ground biomass, 100 seed weight and grain yield was related to S3 (30 kg/ha), followed by S2 (15 kg/ha) and S1 (0 kg/ha), respectively. 100% application of fertilizer (F3) had obtained the maximum spike weight, above ground biomass, 100 seed weight and grain in both 2016 and 2017. Our data have shown that the applied SAP had a remarkable effect on corn growth and yield under different fertilization treatments, and its application of 30 kg/ha gave the best corn production index.

Keywords: maize; grain yield; 100 seed weight; fertilizer.

INTRODUCTION

Appropriate agronomical managements are necessary to meet the

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growing needs for food production (Shahrajabian *et al.,* 2011; Soleymani and Shahrajabian, 2012; Shahrajabian *et al.,* 2013; Soleymani *et al.,* 2013; Ogbaji *et al.,* 2013; Soleymani *et al.,* 2016; Soleymani and Shahrajabian, 2017; Shahrajabian and Soleymani, 2017; Shahrajabian *et al.,* 2017; Yong *et al.,* 2017; Abdollahi *et al.,* 2018; Shahrajabian *et al.,* 2018; Soleymani and Shahrajabian, 2018). Drought stress and water shortage is one of the most important restricting factors in crop production in the world (Soleymani *et al.,* 2011; Amini *et al.,* 2012; Ogbaji *et al.,* 2018). Corn (*Zea mays* L.) requires large quantities of water and fertilizers to grow and develop its organs (Orosz *et al.,* 2009; Khoshkharam *et al.,* 2010; Soleymani *et al.,* 2012).

Corn is one the most important cereal crops grown in Iran, and the demand for maize production for food, animal and industrial use is increasing rapidly as populations increased (Broumand *et al.,* 2010; Esfandiary *et al.,* 2011). The polymers can retain water and fertilizers which will be released when necessary (Zhuang *et al.,* 2007).

The water-saving absorbent polymer is a new kind of high molecular polymer that was first introduced by United States Department of Agriculture in 1969 (Harper *et al.*, 1972). SAP can absorb water, and then swell depen-ding on the water volume absorbed (Zhuang *et al.,* 2007).The serious water deficits and deteriorating environmental quality are threatening agricultural productivity and environ-mental sustainability (Liu *et al.,* 2001). So, there is an increasing need to reduce the uses of inorganic fertilizers along with water-saving superabsorbent polymer (SAP) for field crop (such as corn) production.

Water and fertilizers are the most important factors of plant growth, which greatly influence the crop yield and quality. The polymers can retain water and fertilizers, which will be released when necessary (Zhuang *et al.,* 2007). Some studies have shown that applying SAP in production had a positive effect on plant physiology, such as relative chlorophyll content, photosynthetic indexes, and improved the crop yield and quality (Khadem *et al.,* 2010). SAP can absorb water, and then swell depending on the water volume absorbed (Zhuang *et al.,* 2007). SAP has an ability to enhance seed germination, promote the emerging and survival rate of seedlings, alleviate water stress damage to plants, reduce the irrigation requirement of plants, and improve the crop yield and quality. The aim of this paper is to determine the influence of super polymer absorbent on yield and yield components of corn in semi-arid region of Iran.

MATERIAL AND METHODS

The field experiments were conducted at Isfahan Agriculture Research Station (Latitude $32^{o}30^{/}$ N, longitude $51^{o}49^{/}$ E, and 1541 m elevation), during growing season in 2016 and 2017. The soil of 36 pots used in this experiment was collected from a corn field of experimental station. The pots were 30 cm diameter and 100 cm height. Because of soil richness in P and K, for providing N element, N fertilizer was applied in two split (half of it was used before sowing and half of it was used one week before anthesis stage). All SAP was applied as base fertilizer. The four granules of seeds were sown into each pot and thinned out to one plant per stand. A complete randomized design with four replications was used to analysis the data. Treatments with super absorbent polymer were 0 kg/ha (S1), 15 kg/ha (S2), 30 kg/ha (S3), and treatments with fertilizers were 50% (F1), 75% (F2), 100% (F3), which could be combined into nine pots. All of samples were over dried for the determination of grain weight, above-ground biomass, spike weight and 100 seeds weight of summer corn, which were carried out after harvest. The grains were oven dried at 70℃ for 48 hrs. The aboveground parts were oven dried at 105℃ for 1 hour, and then were oven dried at 70℃ for 48 hrs. An analysis of variance was performed using the Statistical Analysis System 2009 (SAS Institute Inc., Cary, NC, USA) software. Treatment means were compared using the Fisher's protected least significant differences (LSD) at the 5% level of probability.

RESULTS AND DISCUSSION

The influence of super absorbent polymer was significant on spike weight in 2017, above-ground biomass in 2016, 100 seed weight in 2016, and grain yield in 2017. There was no meaningful influence of super absorbent polymer on spike weight in 2016, above-ground biomass in 2017, 100 seed weight in 2017 and grain yield in 2016. Fertilizer treatments had significant influence on spike weight, above-ground biomass, 100 seed weight, and grain yield in both 2016 and 2017 (*Table 1*).

The highest spike weight in 2016 was related to application of 30 kg/ha SAP (159.01 g), which had no meaningful differences with others. The highest value for spike weight in 2017 was related to S3 (30 kg/ha), followed by S2 and S1. All differences between treatments were meaningful. The highest above-ground biomass in 2016 and 2017 was related to S3. In 2016, the maximum above ground biomass was obtained for S3, which was 450.28 g, which had meaningful differences with the minimum one S1 (421.96 g). In 2017, although the highest above ground biomass was related to S3 (348.81 g), it had no significant differences with other treatments. In both 2016 and 2017, the highest 100 seed weight was achieved in S3 and the values were 39.42 g, and 32.96 g, respectively. In 2016, there was a significant difference in 100 seed weight between S1 and other treatments, but in 2017, no meaningful differences were found between treatments. In 2016, the highest grain yield was achieved in S3 (155.2 g), followed by S2 (152.64 g), and S1 (150.25 g). There were no meaningful differences between treatments. In 2017, the higher value of grain yield was related to S3 (118.94 g), followed by S2 (114.12 g), and S1 (108.10 g). Although, there was no significant difference in grain yield between S1 and S2, but both of treatments had meaningful differences with S3. In both 2016 and 2017, the maximum spike weight was obtained for F3, which was 164.63 g, and 171.35 g, respectively. In 2016, all differences were meaningful, but in the next year of experiment, there was just a meaningful difference between F1 and F3. The maximum above-ground biomass in 2016 and 2017 was related to F3, which was 462.44 g, and 362.91 g, respectively. The minimum was also related to F1. In 2016, all differences between treatments were meaningful, while in 2017, there was just significant difference between F3 and F1. In 2016, the maximum and the minimum 100 seed weight were 39.96 g, and 28.27 g, respectively. Although, F1 had meaningful differences with F2 and F3, no significant difference was found between F2 and F3. In 2017, the higher value of 100 seed weight was related to F3 (34.22 g), followed by F2 (32.10 g), and F1 (28.27 g), respectively. Although, there was no significant difference on 100 seed weight between F2 and F1, both of them had meaningful differences with F3. The higher value of grain yield was related to F3 in both 2016 and 2017, and the values were 161.69 g and 127.47 g, respectively. The minimum grain yield in both years of experiment was obtained for F1. In 2016, all differences between treatments, namely F1, F2 and F3, were significant, while in 2017, there was significant difference in grain yield between F3 and F1. There were no meaningful differences between F2 and other treatments in 2017. The interaction between SAP and fertilizers had significant effect on above ground biomass in 2017 (*Table 1*).

Table 1 - Mean comparison for spike weight (g), one hundred seed weight (g), above-ground biomass (g), and grain yield (g) of corn in 2016 and 2017

Treatment	Spike weight (g)	Spike weight (g)	Above-ground biomass (g)	Above-ground biomass (g)	One hundred seed weight (g)	One hundred seed weight (g)	Grain yield (g)	Grain yield (g)
Year	2016	2017	2016	2017	2016	2017	2016	2017
S1	151.25a	136.87b	421.06b	325.11a	37.07b	30.01a	150.25a	108.10b
S2	154.37a	142.06ab	436.89a	329.26a	39.04a	31.61a	152.64a	114.12b
S3	159.03a	170.72a	450.28a	348.81a	39.42a	32.96a	155.34a	118.94a
F1	147.57b	139.09b	410.28c	308.99b	36.07b	28.27b	143.29c	101.99b
F2	152.45b	141.20ab	435.50b	336.28ab	39.50a	32.10b	151.25b	111.71ab
F3	164.63a	171.35a	462.44a	362.91a	39.96a	34.22a	161.69a	127.47a
S×F	ns	ns	*	ns	ns	ns	ns	ns

Common letters within each column do not differ significantly ($p < 0.05$). Treatments with super absorbent polymer were 0 kg/ha (S1), 15 kg/ha (S2), 30 kg/ha (S3), and treatments with fertilizers were 50% (F1), 75% (F2), 100% (F3).

CONCLUSION

Excessive application of chemical fertilizers in Iran is one of the main factor responsible for low farmland fertilizer efficiency and deteriorative environmental sustain-ability.

Super absorbent polymers have been used as water-retaining materials in agricultural and horticultural field because when they incorporate with soil, they can retain large quantities of water and nutrients, which are released slowly as required by the plant to improve growth under limited water supply.

In both years, the highest spike weight, above ground biomass, one hundred seed weight and grain yield was related to S3 (30 kg/ha), followed by S2 (15 kg/ha) and S1 (0 kg/ha), respectively; 100% application of fertilizer (F3) had obtained the maximum spike weight, above ground biomass, 100 seed weight and grain in both 2016 and 2017.

Our data have shown that the applied SAP had a remarkable effect on corn growth and yield under different fertilization treatments, and its application of 30 kg/ha gave the best corn production index. Super absorbent polymers has the ability to absorb and retain nutrients dissolved in water by osmotic pressure, it was characterized with hydrophilic groups at the surface and in the interior which absorb nutrients by hydrogen bonds.

REFERENCES

Abdollahi, M., Soleymani, A. & Shahrajabian, M.H. (2018). Evaluation of yield and some of physiological indices of potato cultivars in relation to chemical, biological and manure fertilizers. *Cercet.Agron.Mold.*, 2(174): 53-66, DOI: 10.2478/cerce-2018-0016

Amini, A.R., Soleymani, A. & Shahrajabian, M.H. (2012). The effects of irrigation disruption on forage yield of four barley's cultivars in different growth and development stages. *IJACS journal,* 4(7): 372-376.

Broumand, P., Rezaei, A., Soleymani, A., Shahrajabian, M.H. & Noory, A. (2010). Influence of forage clipping and top dressing of nitrogen fertilizer on grain yield of cereal crops in dual purpose cultivation system. *Research on Crops*, 11(3): 603-613.

Esfandiari, M., Soleymani, A., Shahrajabian, M.H. & Darkhal, H. (2011). Effect of planting methods on grain yield and leaf orientation at different stages of corn cultivars. *Research on Crops*, 12(2): 336-340.

Harper, B.G., Bashaw, R.N. & Atkins, B.L. (1972). Absorbent product containing a hydrocelloidal compo-sition, US Patent 3, 669,103.

Khadem, S.A., Galavi, M., Ramrodi, M., Mousavi, S.R., Rousta, M.J. & Rezvani-Moghadam, P. (2010). Effect of animal manure and superabsorbent polymer on corn leaf relative water content, cell mem-brane stability and leaf chlorophyll content under dry condition. *AJCS journal,* 4(8): 642-647.

Khoshkharam, M., Rezaei, A., Soleymani, A. & Shahrajabian, M.H. (2010). Effects of tillage and residue management on yield components and yield of maize in second cropping after barley. *Research on Crops*, 11(3): 659-666.

Liu, C.M., Yu, J.J. & Kendy, E. (2001). Groundwater exploitation and its impact on the environment in the North China Plain. *Water Int.*, 26(2): 265-272, DOI: 10.1080/02508060 108686913

Ogbaji, P.O., Shahrajabian, M.H. & Xue, X. (2013). Changes in germination and primarily growth of three cultivars of tomato under diatomite and soil materials in auto-irrigation system. *Int.J.Biol.*, 5(3): 80-84, DOI: 10.5539/ijb.v5n3p80

Ogbaji, P.O., Li, J., Xue, X., Shahrajabian, M.H. & Eneji, A.E. (2018). Mineralogical and textural characteristics of soil of Hancheng and Shaanxi province, China. *Commun.Soil Sci.Plan.,* 49(2): 1-5, DOI: 10.1080/00103624.2017.1421 217

Orosz, F., Jakab, S., Losak, T. & Slezak, K. (2009). Effect of fertilizer application to sweet corn (*Zea mays*) grown on sandy soil. *J.Environ.Biol.,* 30(6): 933-938.

Shahrajabian, M. H., Soleymani, A. & Naranjani, L. (2011). Grain yield and forage characteristics of forage sorghum under different plant densities and nitrogen levels in second cropping after barley in Isfahan, Iran. *Research on Crops*, 12(1): 68-78.

Shahrajabian, M.H., Xue, X., Soleymani, A., Ogbaji, P.O. & Hu, Y. (2013). Evaluation of physiological indices of winter wheat under different irrigation treatments using weighing lysimeter. *Int.J.Farm.Alli.Sci.*, 2(24): 1192-1197.

Shahrajabian, M.H. & Soleymani, A. (2017). Responses of physiological indices of forage sorghum under different plant populations in various nitrogen fertilizer treatments. *Int.J. Plant Soil Sci.,* 15(2): 1-8.

Shahrajabian, M.H., Soleymani, A., Ogbaji, P.O. & Xue, X. (2017). Impact of different irrigation managements on soil water consumption, grain yield, seed protein, phosphorus and potassium of winter wheat. *Cercet.Agron.Mold.,* 3(171): 5-13, DOI: 10.1515/cerce-2017-0021

Shahrajabian, M.H., Sun, W. & Cheng, Q. (2018). A review of Goji berry (*Lycium barbarum*) in traditional Chinese medicine as a promising organic superfood and superfruit in modern industry. *Acad.J.Med.Plants*, 6(12): 437-445.

Soleymani, A., Khajedin, A.A. & Shahrajabian, M.H. (2011). Grain yield and yield components of corn (*Zea mays* L.) hybrids in response to planting dates in semi-arid region in Isfahan. *Research on Crops*, 12(1): 45-52.

Soleymani, A. & Shahrajabian, M.H. (2012). Study of cold stress on the germination and seedling stage and determination of recovery in rice varieties. *Int.J.Biol.,* 4(4): 23-30, DOI:10.5539/ijb.v4n4p23

Soleymani, A., Shahrajabian, M.H. & Khoshkharam, M. (2012). Effect of different fertility systems on fresh forage yield and qualitative traits of forage corn. *Research on Crops*, 13(3): 861-865.

Soleymani, A., Almodares, A. & Shahrajabian, M.H. (2013). The effects of plant densities on LAI and dry matter of different parts of sweet sorghum cultivars. *Int.J.Agron. Plant Prod.*, 4(3): 541-544.

Soleymani, A., Shahrajabian M.H. & Naranjani, L. (2013). Effect of planting dates and different levels of nitrogen on seed yield and yield components of nuts sunflower (*Helianthus annuus* L.). *African J.Agric.Res.,* 8(46): 5802-5805.

Soleymani, A., Shahrajabian, M.H. & Khoshkharam, M. (2016). The impact of barley residue management and tillage on forage maize. *Rom.Agric.Res.,*33: 161-167.

Soleymani, A. & Shahrajabian, M.H. (2017). Effects of planting dates and row distance on sugar content, root yield and solar radiation absorption in sugar beet at different plant densities. *Rom. Agric.Res*., 34: 1-11.

Soleymani, A. & Shahrajabian, M.H. (2018). Changes in germination and seedling growth of different cultivars of cumin to drought stress. *Cercet.Agron.Mold*., 1(173): 91-100, DOI: 10.2478/cerce-2018-0008

Yong, Y., Hu, Y., Shahrajabian, M.H., Ren, C., Guo, L., Wang, C. & Zeng, Z. (2017). Organic matter, protein percentage, yield, competition and economics of oat-soybean and oat-ground nut intercropping systems in Northern China. *Cercet. Agron. Mold*., 3(171): 25-35, DOI: 10.1515/cerce-2017-0023

Zhuang, W.H., Feng, H. & Wu, P.T. (2007). Development of super absorbent polymer and its application in agriculture. *Transactions of the CSAE*, 23(6): 265-270.