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Review Article

Impact of Foliar Application of Magnesium Fertilizer on Agronomic Crops: A Review

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ABSTRACT

Magnesium is an important nutrient and plays a significant role formation and development of sink organs such as seeds and roots. Moreover, its fertilization significantly affects crop yield and many physiological processes in various crop species. Furthermore, its deficiency caused reduction in germination and crop stand. However, its adequate amount through foliar application plays a significant role in physiological and biochemical process of plants such as enzymes activation, proteins synthesis, metabolism of carbohydrates and transferring of energy. Globally, many of our agronomic crops are facing problem of low yield due to inadequate amount of fertilizer application. The present review focuses on impact of foliar application of magnesium on some agronomic crops (wheat, sunflower, maize, soybean, beans, cotton and brassica).

Keywords: *Magnesium; Crop Yield; Physiological Processes; Deficiency; Foliar application; Agronomic Crops.*

INTRODUCTION

Agriculture sector is providing fiber, fuel and food to humans (Adnan, 2020a). Agriculture production is becoming a major challenge to fulfill the requirements of growing population (Adnan et al., 2020a). Magnesium (Mg) fertilizer plays important role in many physiological functions of plants. The most important Mg function in formation and development of sink organs such as seeds and roots (Ceylan et al., 2016). Its deficiency mostly occurs in the regions where highly acidic weathered soils are spread with its more removal from soils takes place (Wang et al., 2019).

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Moreover, it has also been documented that concentrations of Mg in the cereals crops displays a clear decline over last 60 years, most possibly due to Mg dilution associated with increases in the grain yield as well as due to imbalanced fertilization without knowing crop demand for the Mg (Guo et al., 2016). Its fertilization significantly affects crop yield and many physiological processes in various crop species, as well as Mg agronomic efficiencies, under different soil conditions remain the most important question to be addressed publically because its deficiency in plants caused lower amount of starch and reduction in germination and seedling establishment when compared Mg adequate plants (Wang et al., 2020). Fertilizers can be applied to crops by soil and foliar application but foliar application is easy and economical (Toor et al., 2020 & Adnan et al., 2020b). Foliar application of magnesium plays a very important role in the physiological and biochemical process of plants such as enzymes activation, proteins synthesis, metabolism of carbohydrates and transferring of energy as well as magnesium also performs as a catalyst in oxidation and reduction reactions inside the tissues of plant whereas magnesium increases the crop resistant to drought (Thalooth et al., 1990). The present review focuses on impact of foliar application of magnesium on some agronomic crops (wheat, sunflower, maize, soybean, beans, cotton and brassica).

1. Wheat

Wheat is an important crop all over the world (Adnan et al., 2020c; Ali et al., 2020a & Anjum et al., 2020). EL-Metwally et al. (2010) carried out two field experiments in spring season during 2007-2008 and 2008-2009 at Ismailia experimental station Egypt to evaluate the foliar application of magnesium and copper with nine treatments were applied either single or in combination on growth of wheat, two treatments of Mg, two treatments of Cu, and four treatments of combined (Cu+Mg) and one treatment of control and found that highest foliar application of magnesium and copper levels (6.72 kg Mg + 1.68 kg Cu/fed) produced excellent effect on flag leaf area, chlorophyll contents and dry matter per square meter.

2. Sunflower

Sunflower is an important crop (Haq et al., 2020). Krizmanic et al. (1998) carried out an experiment to study the response of magnesium sulphate on Nine cultivars of sunflower i.e. Fakir, Orion, Olio, Sokac, Miro, Gordan, OS-H-433, Viki and Sunce. Four replications were tested by 5% Epsom salt solution at bud formation and at flowering times and the other four replications were reserved for control. The results were determined that application of Epsom salt $MgSO_4.7H_2O$ increased grain yield (11% on moisture basis) and oil content. Ram and Bose (2000) studied the effect of magnesium with the combination of micro nutrients Mg+Cu+Zn on production and quality of fruit of mandarin orange and noted that height of plant, girth of stem and spread of the plant as well as enhanced the juice content.

3. Maize

Maize is an important crop (Ali et al., 2020b; Asif et al., 2020; Adnan & Bilal, 2020; Adnan, 2020b & Wasaya et al., 2019). Rasheed et al. (2003) carried out an experiment to investigate the crop growth of hybrid maize under various cultivation methods and different concentrations of elements. Different nutrient concentrations be used for experiment. The plants were cultivated in ridges which obtained higher leaf area index (5.22), total dry matter production (1478 g per square meter and net assimilation rate 8.09 g per square meter per day. 15 kg sulphur applied along with the application of NP 250 -150 kg obtained considerably higher leaf area index, total dry matter, and net assimilation rate without NP. While, Sulphur or magnesium or application of both the nutrients produced higher leaf area index, total dry matter and Net assimilation rate than without NPK but statistically similar to each other. Abunyewa and Mercer-Quarshie (2004) carried out an experiment in the semi-arid area of West Africa. Two nitrogen doses @ (40, 90 kg ha^{-1}) were applied to main plot and three concentrations of magnesium sulphate (0, 15, 25 kg ha^{-1}) and three concentrations of zinc sulphate (0, 5, 10 kg ha^{-1}) were applied to maize in sub plots. The production of maize was increase from (0.6-16.5%) by magnesium application @ (1.3-2.8 t ha^{-1}), however the production of maize was increase from (84-108%) by zinc application @ (0.9-3.2 t ha^{-1}) during three-year period and also the combination of magnesium and zinc increased the maize yield form (27-150%) by both combined Mg and Zn application @ (0.97 and 2.2 t ha^{-1}) compared with control. Yarnia et al. (2013) Studied the impacts of a foliar applications in different mixtures of nutrients and seed production in later levels of dosing evaluated in the examination were as follows: The four growth periods; eight to Ten leaf, tasseling, seed filling and at all the phases and 7 foliar spray of methanol, zinc, boron, magnesium, nitrogen, manganese, amalgamation of all unions and a separate field plots as a control. Result indicated that great conclusions of the fusion type whole year effort in different phases, on resources of nitrogen, magnesium, zinc, manganese, boron and seed production in the after word steps while a period of one-year with mixture of all the association in all greats had the loftier stock of nitrogen in seeds (1/45%). The effects also showed that the term of one-year treatment of magnesium at all phases had the maximized impact on magnesium backlog in seeds (0/172 mg per kg) and zinc foliar spray at the tasseling level had the utmost conclusion on backlog zinc of seed (44 mg per kg). Manganese foliar spray at the eight to Ten leaf phase had the higher value on backlog manganese of seed (12 mg per kg) and boron foliar spray at all phases had the best effect on stock of boron of seed (9/1 mg per kg). Results proved that all mixture at all phases had the loftier impact (1309 g per square meter) and at the tasseling phase had a least (713 g per square meter) seed production in the later degree.

4. Soybean

Soybean is an important crop (Khan et al., 2020a & Khan et al., 2020b). Vrataric et al. (2006) carried out an experiment in Eastern Croatia during four years (1998-2001) to examine the six cultivars of soybean (Glycine max (L.) Merr) maturity groups 0 and I were assessed in relative to the response to foliar application with two concentrations of Epsom salt (ESFF) on grain yield, protein and oil content in grain. The recorded data revealed that significant enhancing of grain yield, protein and oil content in grain pretentious by ESFF. However, the examined characters were non-significant differences among two treatment concentration but the interaction of Epsom salt with cultivars as well as with years were significant, respectively. Odeleye et al. (2007) conducted an experiment of pot and field trials to study the effects of foliar application of nutrient on soybean growth and production. The soybean cultivar TGX 1740-2F was tested in the experiment and nutrients were foliarly applied as wholly N, NPK and NPKMg at the early flowering and early pod-filling growth phases. Plants were foliarly treated at the level of 100 mg per liter of water consequent to each nutrient, while unsprayed plants served as control. Results indicated that foliar application of nutrients, either single or in combination, significantly improved the growth and production of the TGX 1740-2F soybean cultivar, at both growth stages. But, spraying nutrients during an early pod filling stage was significantly better than spraying at the early flowering growth phase. The maximum production of soybean was recorded by spraying NPK and NPK, Mg.

5. Beans

Saad and kholy. (2001) laid out an experiment in Egypt during 1994/95 and 1995/96 to determine the response of two faba bean cultivars (Giza Blanka & Giza 402) to phosphorus, orthophosphoric acid and magnesium. The phosphorus was applied (32 kg P_2O_5 at planting time and foliar application of orthophosphoric acid 0.35% at six and eight weeks after sowing and foliar spray of magnesium sulphate combined with 0 and 2 g/litre of water 43 and 57 days after planting). The data was recorded and results indicated that Giza Blanka produced maximum number of branches $plant^{-1}$, dry weight of leaves, photosynthetic pigment content, 100-grain weight, harvest index and seed, straw and biological yield, however, the lowest plant height, number of pods per plant, number of seeds per pod and protein percentage in seeds. Most of the growth parameters, photosynthetic pigment contents and yield components enhanced with the foliar application of phosphorus and magnesium as well as magnesium and phosphorus have positive effect on seed yield and the number of branches, leaf dry weight, total dry weight, carotenoids, seed weight, harvest index and straw, biological yield, chlorophyll a and chlorophyll b. Rupp et al. (2002) study the foliar spray of magnesium sulphate or with Magnesium oxide is protected as regards quality of wine. Ali et al. (2009) concluded that magnesium and nitrogen application affected the number of grains per cob. The highest number of grains (374.1) per cob was obtained from the treatment, where magnesium was applied at the rate of 15 kg per hectare and nitrogen at the rate of 200 kg per hectare, respectively. The highest cob length (18.23 cm) was recorded from the plot fertilized at the rate of 200 kg nitrogen and 10 kg magnesium per hectare. The highest yield of 7.64 tonns per hectare was obtained from the plot where nitrogen and magnesium was applied at the rate of 200 kg, 10 kg per hectare, respectively.

Stagnari et al. (2009) demonstrated that most of the short period crops have been shown magnesium deficiencies in sandy and clay soils but these deficiencies may be improved by foliar applications, however to determine the effect of foliar application of magnesium @ 56, 112, 224 g ha^{-1} in single application at flowering stage or half dose at 4-leaf stage and half at flowering stage) alone and with zinc (200 g ha^{-1}) on production and quality of two cultivars of French bean (Bronco & Cadillac). It was concluded foliar application of magnesium increase the pod yield deem to be the highest rate with to the untreated like an increase was 78% of Branco and 32% of Cadillac, respectively. Split applications of magnesium were also more effective which enhanced the production of (109% and 50%) of these two cultivars Branco and Cadillac, while the addition of zinc to fertilizer or split application did not give any relevant effect. The foliar application of magnesium enhanced the quality of French bean and also indicated that best effect on sugars, calcium, phosphate, sulphate and magnesium content in pods. Hossain et al. (2011) studied the implications of lime, Mg and boron on production of wheat and also their leftover impact on mungbean. The five treatments for wheat were used such as (i) recommended fertilizer + Mg + B, (ii) recommended fertilizer + lime + B + Mg, (iii) recommended fertilizer + lime + Mg, (iv) recommended fertilizer + lime + B and (v) control (Only recommended fertilizer) and for mungbean were (i) recommended fertilizer + Mg + B, (ii) 75% of recommended dose, (iii) recommended fertilizer + B, (iv) recommended fertilizer + Mg and (v) control (without fertilizers). The conclusions pointed out that the maximum yield and yield components of wheat were noted from recommended fertilizers + lime + B + Mg dosing plot and the subsequent maximum were noted from recommended fertilizers + lime + Mg treated plot. However, the minimum was noted in control plot. In mungbean the maximum was obtained from recommended fertilizers + B dosing plot, this conduction was limed in formerly growing wheat crop and the minimum was noted from control plot.

6. Cotton

Oil seed crops are very important for human food (Hussain et al., 2020). Kulkarni et al. (2010) laid out an experiment on medium black soil during 2009-10 to examine the effect of Bt cotton (Gossypium hirsutum L.) to foliar nutrition under watered condition. There were 15 treatments were selected in combinations containing of foliar sprays of five major and secondary nutrients (viz., control, KNO_3 @2.0%, $MgSO_4$ @1.0%, DAP @ 2.0% and $MgSO_4$ @ 1.0% + KNO_3 @ 2.0%) at flower initiation, boll formation and boll development stages in main plots and three growth regulator and micronutrient sprays (control, NAA @ 10 ppm, NAA @ 10 ppm + $ZnSO_4$ @ 0.5%) at flower initiation and boll development stages in sub plots. Treatments were replicated thrice in split plot design. The foliar application of major and secondary nutrients, $MgSO_4$ + KNO_3 spray noted maximum seed cotton production (2506 kg /ha) and was significantly higher over other treatments except $MgSO_4$ spray (2446 kg /ha) which in turn was on similar with DAP spray (2389 kg /ha). Both $MgSO_4$ and DAP were significantly higher over KNO_3 spray (2283 kg /ha). Significantly lowest seed cotton production was noted with control (2008 kg /ha). Significantly higher seed cotton yield (2469 kg /ha) was found with spraying of NAA + $ZnSO_4$ over the treatment which received NAA spray (2327 kg /ha) which inturn was significantly higher over control (water spray) (2183 kg /ha). The uptake of nutrients (N, P, K and Zn) indicated the similar trend and the economic analysis showed that spraying of $MgSO_4$ + KNO_3 (Rs. 39,483 /ha) and $MgSO_4$ (Rs. 40,917 /ha) resulted in significantly higher net returns than control (Rs. 31,100/ha). Foliar spray of NAA + $ZnSO_4$ (Rs. 39,051/ha) resulted in significantly higher net returns and it was on similar with NAA spray (Rs. 38,301 /ha). Significantly lower net return was obtained with control (Rs. 34,756/ha) treatment. The results can be determined that higher seed cotton yield and net returns can be attained with foliar application of $MgSO_4$ @ 1.0% at flower initiation, boll formation and boll development stages along with NAA @ 10 ppm+ $ZnSO_4$ @ 0.5% at flower initiation and boll development stages. Singh et al. (2015) studied the effect of different foliar application N, Mg, Fe, Zn, Mn and B on growth and yield parameters of Bt cotton. The results were obtained that highest production of seed cotton (3421.4 kg/ha) with the foliar applications of $MgSo_4$ 1% + $ZnSo_4$ 0.5%.

7. Brassica

Amal et al. (2014) conducted an experiment in winter season of 2012/2013 and 2013/2014 at the Agriculture Research Farm, El-Kassasien Horticulture Research Station Egypt to test the effect of foliar application of iron (Fe) and magnesium (Mg) i.e. Fe at 50 and 100 ppm, Mg at 0.5 and 1.0%, Fe at 50 ppm + Mg at 0.5%, Fe at 50 ppm + Mg at 1.0%, Fe at 100 ppm + Mg at 0.5% and Fe at 100 ppm + Mg at 1.0% as well as the control on growth, yield, chemical constituents and storability of broccoli Sakura F1 hybrid (Brassica oleracea var. italica), grown under sandy soil conditions using drip irrigation system. The broccoli plants were spraying with Fe at 100 ppm plus Mg at 0.5% or 1.0% significantly enhanced all the examined vegetative growth characters compared with other studied treatments with non-significant differences between them. Significant improving in the yield and yield components and chemical constituents of broccoli florets [Fe (ppm), Mg (ppm), nitrogen and protein%] were noted by foliar application of Fe at 100 ppm plus Mg at 0.5% or 1.0% with non-significant differences between them. About quality parameters of broccoli florets during storage at 5°C and 90-95% RH for 15 days, the results indicated that visual appearance, ascorbic acid content and external color of broccoli florets were reduced as the storage period enhanced. The broccoli florets attained from plants treated with Fe at 100 ppm plus Mg at 0.5% or 1.0% showed acceptable appearance, fresh green color florets and higher ascorbic acid (vit. C.) content during storage as compared with the control or other treatments.

CONCLUSIONS

Our review has shown that magnesium is an important factor limiting agriculture crop production but its negative effects of can be minimized by the foliar application of Mg. It is very important plant nutrient for all crops. Foliar application of Mg fertilizer is recommended for correcting deficiencies because foliar sprays have no residual effect and fresh applications must be made to each crop. Moreover, the amount depends upon the crop and soil nutrient status.

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