Effects of Inducing Plant Growth on performance and performance Components of Corn (*Zea mays* L.)

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In order to examine the effect of spraying plant growth inducers on performance and performance components of corn in the double-cross 704 corn, a test in the form of a randomized complete block design under condition of a farm with eight replications and six treatments of plant growth inducers, Marmarine, HB_101, auxin, cycocel, ethephon and control was performed. Analysis of variance of data showed that characteristics of the number of rows of grain, number of grains per row, number of grains per maize, grain weight per maize, weight of 1000 grains, cob weight, grain performance and harvest index were significant at the 5% level. The Marmaryn , HB-101 and auxin treatment led to increase in the number of rows of grain, number of grains per row, number of grains per maize, grain weight per maize, weight of 1000 grains, cob weight, grain performance and harvest index. So that the greatest value was related to Marmarine treatment, then HB_101 treatment and eventually auxin treatment. Also, Cycocel did not indicate any significant effect on the performance and performance components of corn except for reducing the weight of 1000 grains. Ethephon decreased grain number per row, number of grains per maize, weight of 1000 grains and cob weight, but its impact on the performance was not statistically significant.
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Key words: performance components, inducing plant growth substances, and corn.

Introduction

Corn (zea mays L.) has the maximum production among grains, and in terms of area under cultivation has the third place after wheat and rice (Tajbakhsh, 1375). Corn is one of the cheapest and purest sources of organic material for industrial use. In starch factories, animal feed, sugar syrup and oil are extracted from the corn starch. Today, more than 500 types of product of the second degree are obtained from corn (Noormohammadi et al, 1380). Performance in the corn is about grain production per unit area and grain weight, from which grain weight is more stable, and large difference in performance is usually a result of change in number of grains. On the other hand, Ten percent of the total dry substance of the grain is provided by remobilization of stored substance in the vegetative organs, although this value is low, but regardless of daily fluctuations in photosynthesis, this photosynthetic substance is really essential in keep the grain dry substance constant during the stage of filling of the grain (Duncan et al, 1965). Also, the cereal grain only includes some parts of the produced biomass. High performance in a variety of new products is in relation to their biological function, provided that the biomass of produced organs, and their distribution is for grain production, which in turn is depended on the high development of photosynthetic apparatus and roots in the vegetative phase and rapid increase in dry matter production in reproductive phase (Kuchaki & Banayan, 1373), and the absorption rate of nutrients in maize is reduced after flowering (Fathi and Ismailpoor, 1379). Experimental results show that the mobility of stem reserves, which includes the surplus products of photosynthesis before the grain filling stage, has contributed largely to the grain performance. This is very important particularly in the occurrence of tensions such as dryness and high temperatures in the stage of grain filling (Austin at el, 1980 at el, 1976 and Gallagher).

Due to what mentioned above, using inducing produce plant growth substances may provide these conditions for high performance and production. Plant growth regulators which are used on financial products have a direct or indirect influence on final fruiting, product quality or both (Mojabi, 1373). Indole Aceto Nytryl is a hormone first extracted from the leaves and stems of organic plants of Cruciferae family (Jones et al, 1952). The Auxin term is derived from a Greek word means the growth, and along with longitudinal growth, may also affect other processes. But its impact on the longitudinal growth is of more concern (Fathi, 1378). The plant response to auxin is changing from the

effect on cell metabolism to coordination for physical structure of plants including falling leaves and the plant aging, and its cellular effects includs an increase in proton exchange, membrane load, and potassium absorption (Marre, 1977) and the effect is on phytochrome with red lights (Kuchaki and Sarmadnya, 1377). Also, it is transported through the phloem, and has an important role in the formation of ectopic root and fruit development and tillering of plants (Shabestari and Mojtahedi 1369; Artec et al, 1980). Research reports show that the application of cycocel can change number of tillers, and increase in number of tillers is done through the response to the daylong, preventing from the biosynthesis, and auxin transport or change in Osylylate or nutrents (Lungw at el, 1982). In response of wheat to leaf consumption of cycocel, despite the general reduction in plant height and lodging rates, no significant increase in grain performance is observed (Sarkar et al, 2002). Cycocel increases the production of short inter-nodes and the vascular bundles (Prakash and Ramachandran, 2000), and by affecting the performance factors, increases the grain performance, and fertilizer capacity of the plant (Fabebri et al, 1986). In cereals, it increases the number of spikes per area unit, spike length and grains per spike (Shabestari and Mojtahedi 1369; Ma and Smith, 1992), causes lag in aging of lower canopy leaves (Green, 1985), and by creating thicker and darker leaves, increases photosynthesis (Myhre et al., 1973). Ethephon increased tillering in cereals, and since these tillers are competing on photosynthetic materials and minerals absorbed, the number of sterile spikelets are increased, and cycocel treatment of cereals, increases the number of grains per spike, but often decreases the grain size (Shokoufa and Imam, 1384). Ethephon by-releasing Ethylene significantly affects plant growth and development (Davis, 1988), stimulates seed germination (Khajehpour, 1377), is effective in fruiting, increases tillering and rooting in cereals (Foster et al, 1992), and has a direct impact on performance factors (Farrahi Ashtiani et al, 1378; Bulman and Smith 1993). Marmarine is substance induces natural growth and is extracted from marine algae (Ascuphyllum nodusom), and contains more than sixty kinds of food elements, enzymes, organic acids and plant growth inducer (Dadkhahipoor, 1386). In the United Kingdom, the algae are used as fertilizer and growth inducer in various products such as potatoes and cabbages, in tomato increases the period of flowering and fruiting, and makes the earth free from aphids (Dawes, 1981). The existence of hormone compounds like auxin, gibberellin, phenyl acetic acid and citokenin in brown algae has been proved. The amount of corn, rice, tomatoes, potatoes, peppers, oranges, and pineapples is significantly increased by using this type of growth inducers. Also, the production of rice is increased by increasing algae. Especially in the agricultural environment Syanvfys·h the power of the flooding and the amount of rice to 20 percent increase. (Blunden .1972).

Materials and Methods

In this experiment, corn grain (Double Cross 704) with the effect of five growth inducers including ethephon, indole acetic acid, cycocel, H. B. _101, and Marmarine, and control group (without use of growth inducers) formed the experimental treatments.

The method of testing: testing was performed with 6 treatments and 8 replications in the form of randomized complete block design under field conditions, in the agricultural research stations in Urmia Sa'atlou, in 1387.

Farm operations: land where the experiment was performed was tillaged deeply by the moldboard plow in the Mid April 2008, and after surface rotivator, the farm was plotted. Plots area was with dimensions of 4 × 3 m and plot number was 48. The inner plots were ploughed by the shovel. The seeds were cultured in plots in four rows and with row spacing of 60 × 22, and with 75 thousand plants per hectare and depth of 7 × 5 cm. In order to ensure germination and a nearly complete count of sprigs in each plot, three seeds were placed in each planting hole, and after emergence, and removing the risk of Agrevits, in each hole, the two plants was eliminated and a plant was kept safe. Fertilizers were used according to soil analysis results. 360 kg per hectare of urea in three stages (one-third before cultivation, one third in the stage of having three to four leaves, and one third in the phase of tasseling), and 100 kg per hectare of di-ammonium phosphate and 200 kg per hectare of potassium sulfate were used evenly in all treatments before cultivation. Combating the weeds was performed regularly during the growing season, and in order to prevent drought stress in plants, watering was done regularly and accurately between once in 7-10 days during the whole growing season. According to the test plan, one week before and after pollination, the growth inducer substances treatment was performed twice and in solution form sprayed to leaves and the tested characteristics were measured and noted after treatment till the harvest. Inducer substance and plant growth regulators (treatments) concentration was under field conditions and was as follows: Indole acetic acid 20 ppm, cycocel 100 ppm, ethephon 33 ppm, Marmarine 1.5 liters per thousand liters of water and HB _101 100

cc per thousand liters of water (according to the instructions on the manufacturer and its use on products crops and cereals). Acquired data were analyzed by the Mstat_c software, and variance and mean were compared with LSD test at the five percent level of probability.

Discussion and Result

Results of data analysis (Table 1) showed that application of plant growth inducer substances on the performance and performance components is effective in the corn. The characteristics were rows of grains, grains in rows, number of grains per maize, grain weight per maize, weight of 1000 grains, cob weight, and grain performance, and harvest index was significant at the 5 % level.

The number for rows of grains in maize

Plant growth inducer treatment on the characteristic of the number for rows of grains in maize indicated highly significant statistical difference in ($p < 1$ %). Maximum increase was related to Marmarine, and then HB_ 101 and finally auxin treatment (Figure 1). Usually the number of rows per maize under genetic control mechanisms was always even and usually between 8, 16 and 24 (NoorMohammadi et al, 1380). This characteristic is under genetic control, and less control factors affect it significantly (Kuchaki and Banayan, 1373).

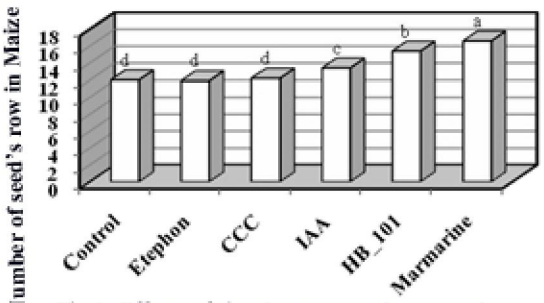

Fig 1: Effects of simultants growth on number of seed's rows in Maize

Plant growth inducer treatment on the characteristic of number of grains in rows per maize, and number of grains per maize indicated highly significant statistical difference ($p < 1$ %). Maximum increase in number of grains in rows per maize was related to Marmarine, and then HB_ 101 treatment. But this characteristic was decreasing dramatically in ethephon treatment, and cicocel decreased it more, but it was not statistically significant (Figure 2). The same results with a minor change were observed in the characteristic of the number of grains per maize. So that Marmarine treatment caused the maximum increase, and Etephone decreased it significantly, and cicocel decreased it insignificantly (Figure 3). Growth inducers do not cause the accumulation of dry matter in grain, but affect the division pattern of dry matter, which depending on environmental conditions may have positive or negative effects on the grain performance (Ma and Smith, 1992).

Table ١. Analysis of randomization complate blocks experiment under field conditions.

		Mean of squares								
S.O.V	*d.f*	Number of rows in Maize	Number of grains in row of Maize	Number of grains in Maize	Length of Maize wood	Weight of Maize wood	Weight of grain in Maize	Weight of thousands seed	Grain performance	Harvest Index
Replication (R)	٢	٣٠٦/١ns	٨٧٨/١٩ns	٠٩٨/٩١٧٥ns	٢٢١/٠ns	٣٥١/١٦ns	٣٠٤/٩٣٩ns	١٧٢/٣٢٢ns	٥١٣٢٦٥٤ns	٤٧٢٥*
Treatment (T)	٥	٩٩٢/٣٠**	٩٢/٥٩٥**	٥٨٤/٣٩٥٥٠**	٢٢١/٧٥**	٢٨١/٣١٧**	٢٨٩/٣٢٦١٥**	٠٤٤/٥٤٠٩**	١٨٤١٠٠٢٨٥٥**	٢٧٧/٤٧٤**
Error	٣٥	٤١/١	٢٢٦/١٢	٧٩٤/٩٤٣٩	١٩٤/١	٨٩٦/٨	٣٧٨/١٠٣٩	١٧٦/٦٠٨	٠٠٧٥٦٦٦٨٠٠	٨٧٥/١٢
% C.V		٨٢/٨	٥٩/٩	٩٤/٥	٠٦/٥	٢٨/١٠	٣٠/١٨	١٥/٩	٨٤/٢١	٩/١٢

ns, * and ** : Not significant, significant at ٥٪ and ١٪ probability levels of probaibility, respectively.

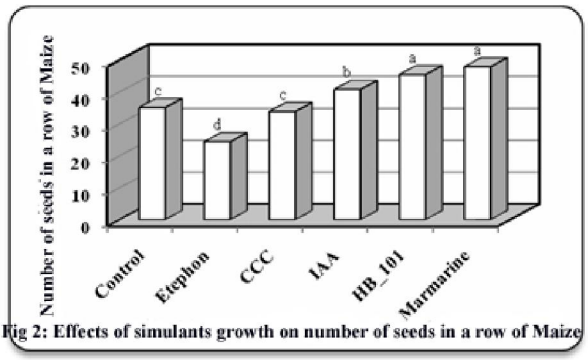

Fig 2: Effects of simulants growth on number of seeds in a row of Maize

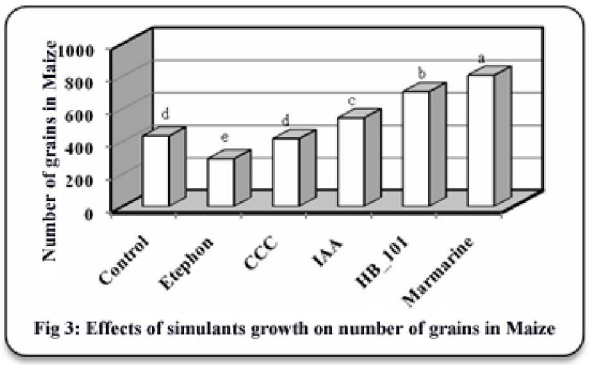

Fig 3: Effects of simulants growth on number of grains in Maize

Any increased duration of grain filling, increases the grain performance and has a large correlation with grain performance. Deficiency in maize pollen is rarely responsible for the lack of fertile eggs, but the main cause is usually late tasseling because of shortages of water, food elements, moving carbohydrates and nitrogenous substances (Kuchaki and Banayan, 1373). The use of algal growth inducing substances causes increased flowering and fruiting period in the tomato (Davies, 1988). Number of spikelets per spike is increased by the use of Indole Acetic Acid in cereals (Shabestari and Mojtahedi, 1369; Sarkar et al, 2002). A factor that negatively affects production of maize in flowering time is reduction in net assimilation rate at the time of flowering till grain filling, and possibly lack of food or water and very high density will exacerbate the negative impact (Kuchaki and Banayan, 1373).

Weight and length of the cob

Weight and length of the cob indicated highly significant statistical difference in plant growth inducer treatment ($p < 1$ %). Weight and length of the cob in cicocel treatment did not indicate significant difference, but Ethephone caused significant difference in these two characteristics. The maximum increase was related to Marmarine, and HB_101 treatment, and then Indole Acetic Acid treatment (figures 4 and 5).

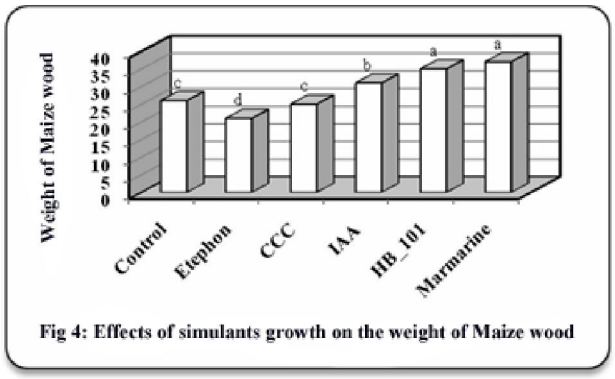

Fig 4: Effects of simulants growth on the weight of Maize wood

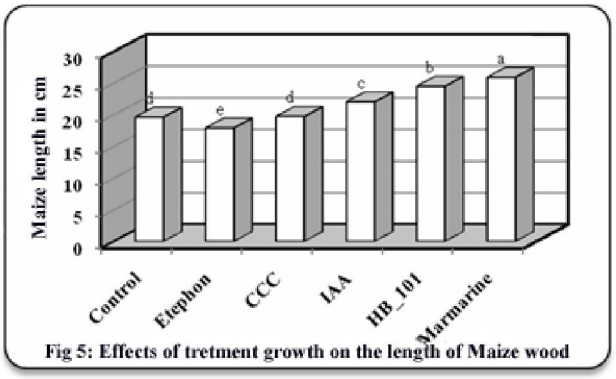

Fig 5: Effects of tretment growth on the length of Maize wood

Cycocel and different levels of nitrogen makes a significant increase in performance of wheat grain for the increase in the number of grains per spike, increase in the length of spikes, and increas ein the number of spikes per area unit (Shokoufa and Imam, 1384). Ethephon increased tillering in cereals and for the competition on photosynthetic substances and mineral absorption, the number of sterile spikelets is increased (Shabestari and Mojtahedi, 1369). Lack of carbohydrates, proteins, and possibly hormonal factors associated with dryness, lack of light in dense environments, cloudy days or nitrogen deficiency causes growth stop and death of fertilized eggs at the tip of the maize, On the other hand, photosynthesis with water absorption and assimilation of food, is provider of energy supply for the performance (Kuchaki and Banayan, 1373). It appears that Marmarine treatment by affecting duration of pollination period and the effective pollination, by enriching the plant by the nitrogen substances, hormones and vitamins, increases the number of grains per row and maize, and the length and weight of cob. Also the impact of HB_101 treatment can be justified because of its effect on increasing the speed of nutrient transport.

Grain weight per maize and weight of 1000 grain

Grain weight per maize and weight of 1000 grains indicated highly significant statistical difference in plant growth inducer treatment ($p < 1$ %). Grain weight was increased respectively by Marmarine, HB_101 and indole acetic acid treatment, and dencrease by ethephon and cycocel. Also, increase in weight of 1000 grains by Marmarine, HB_101 and auxin treatment, and increase in this characteristic by cycocel treatment, and no significant difference by applying ethephone, expalins largely the effect of grain growth inducers used in this study (Figures 6 and 7).

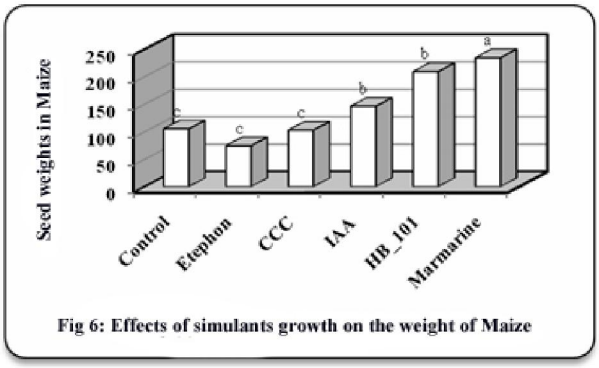

Fig 6: Effects of simulants growth on the weight of Maize

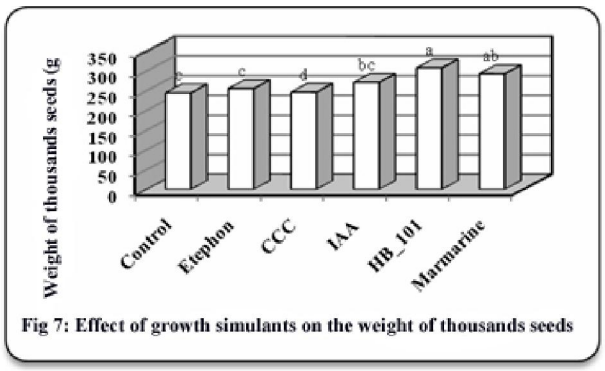

Fig 7: Effect of growth simulants on the weight of thousands seeds

The harvest index and grain performance

The harvest index and grain performance indicated highly significant statistical difference in plant growth inducer treatment ($p < 1$ %). The maximum grain performance increase (economic performance) was related to Marmarine, and then HB_101, and finally indole acetic acid. Other treatments decreased the performance insignificantly. Also, the harvest index indicated the same results as the grain performance (Figures 8 and 9).

Performance in the corn is about grain production per unit area and grain weight, from which grain weight is more stable, and large difference in performance is usually a result of change in number of grains Fathi and Ismailpoor, 1379).

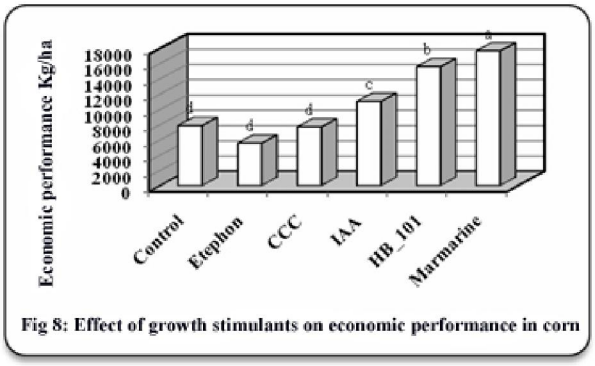

Fig 8: Effect of growth stimulants on economic performance in corn

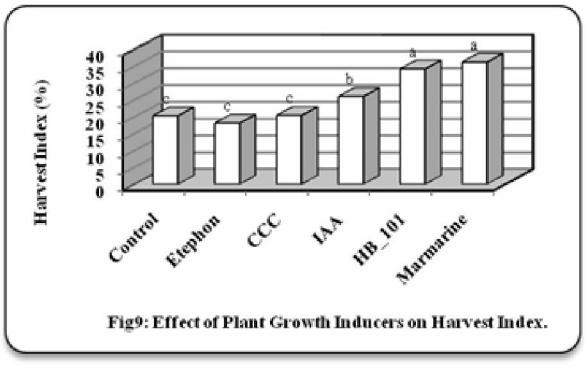

Fig9: Effect of Plant Growth Inducers on Harvest Index.

The number of grians formed, compared with the weight of 1000 grains, increases or decreases the grain performance mostly, and grain filling by photosynthesis substances in maize begins when the grain number is determined. Therefore, the number and size of grains per maize is severely affected by water, nutrients and light (Kuchaki and Banayan, 1373). In the condition that the leaves have a high amount of sucrose, the vascular sheath cells have a higher osmotic potential, and makes the loading easier. It seems that the intensity of photosynthesis is reduced by reducing the rate of acceptance by the target, and allocation of capacity consumed by photosynthetic substances, access to substances and photosynthetic rate substance in this area is controlled. The hormones by affecting the formation, development and the loss of flowers and seeds, have an important influence on the relations between source and destination of plants. And may have effects on speed of transfer, and by having impact on the target requirements (demand) indirectly affect the transfer speed (Kuchaki and Banayan, 1373). Indole acetic acid treatment of cereals causeslateral buds to defeat, therefore reduces the production of tillers, improves the growth of main stem, and finally increases the number and weight of grain in cereals (Sarkar et al, 2002). Environmental stresses such as food shortages or radiation, especially 10-14 days

before pollination, significantly reduce the number of grains per maize (Kuchaki and Banayan, 1373), on the other hand, the factors that control the transfer to destination assimilation have also control on the distribution of photosynthetic substances. The effect of hormones on enzyme activity and flexibility of the target cells have a great impact on the distribution of photosynthetic substances (Kuchaki and Sarmadnia, 1377). Having large amounts of nitrogen and mineral elements and the presence of growth hormones such as auxin, jiberlin, phenyl acetic and citokenin in the algae such as Ascuphyllum nodusom is now proved, and by using them, the production of various products, including corn, potatoes, peppers, tomatoes, pineapple and orange has significantly increased (Blunden, 1972). The test of three year effect of etephone on grain performance in barley indicated that the number of grains in spike is increased, but their size is often reduced (Shabestari and Mojtahedi, 1369). Also with the increase in cycocel consumption, the weight of 1000 grain is reduced (Lungw et al, 1982). Mobilization of stem reserves (including surplus products of photosynthesis before the grain filling stage), is largely involved in grain performance in grain filling stage (Austin et al, 1980; Gllangher et al, 1976). The harvest index indicates the ratio of grain performance and biological function, and is acquired from the ratio of grain performance to the biological function (Kuchaki and Sarmadnia, 1377), so it is rarely influenced by the environment (Fathi, 1378), on the other hand, ninety percent of the corn grain dry matter is provided through photosynthesis during the grain filling, and is depended on leaf area index, leaves long-term activities (particularly upper leaves), the high rate of photosynthesis and photosynthetic substances that is transported to the beads (Kuchaki and Sarmadnia, 1377). The remained ten percent of the corn grain dry matter is provided through remobilization of stored substances in the vegetative organs; although this value is low, but regardless of daily fluctuations in photosynthesis, these photosynthetic substances are vital to keep grain dry matter increase during the grain filling stage (Duncan et al, 1965). According to the results obtained, it appears that the to increase production and higher grain performance in maize, plant growth regulators and growth inducers can be used a week before and after pollination, so that Marmarine by increasing pollination period, insemination and duration of grain filling, and more and faster transfer of photosynthetic substances to the grain, leads to increased number of grains per row and maize length, weight of 1000 grain and eventually grain performance in the corn. HB_101 also increases the grain performance by increasing the number of grains, maize length and weight of 1000 grain. Increase in photosynthesis in the leaves for the rapid absorption of nutrients in the stage before and after pollination, even grain filling by Calcium and sodium ions, which in turn increases the storage of sugar in the plant, and increased speed and duration of grain loading and unloading, can be considered as factors of this effect. Indole acetic acid also increases the effective transfer of photosynthetic substances to the grain, and so increases the relative number of grains and weight of 1000 grains in the corn. Undesirable effect of cycocel and ethephon on grain performance in corn can be caused by plant type and the time of their application. However, for widespread use of these substances, further research is required. The valuable note in this study is increased performance in an important crop such as corn by application of natural growth inducers (Marmarine and HB_101), which in addition to achieving the goals of sustainable agriculture, can be a starting pint for new researches about other important crops.

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