Growth and Yield Performance of Corn Applied with Fertilizer at Different Growth Stages

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Abstract

A field experiment on the growth and yield of corn was conducted to study the effect of boron fertilizer levels applied at its different growth stages. A hybrid variety of corn known as Pioneer was used in the study. It made use of a two-factorial Experiment in Randomized Complete Block Design (RCBD) with four replications. There were four (4) treatment combinations applied at three (3) growth stages of corn. A highly significant effect has been noted on grain yield when corn plants were treated with different levels of boron at different stages of plant growth. The treatment combination 1.6 kg/ha of boron fertilizer applied three times at three stages of growth, greatly improved the yield of corn than the other treatments. Furthermore, three foliar applications of boron fertilizer in vegetative and reproductive stages gave the highest corn yield.

***Keywords**: vegetation, tasseling, silking*

1. INTRODUCTION

Corn (*Zea mays L).* is one of the most important crops in the Philippines. About 20% of the total population uses corn as a staple food. In times of scarcity, corn is good substitute or supplement for rice. It contains a high energy, rich in vitamin B, trace minerals and a source of pro-vitamin A.

Of all cereal grains, corn is the most highly valued for its multifarious uses as human food, animal feed and as raw material for industry. Because of these, the demand of corn is high by our increasing population. But inspite of the country's favorable climate and available technology in increasing the yield, corn production in the country is not adequate to meet the need for food, feed, seed and industry. Therefore, further study on tapping the high-yielding potential of corn is necessary to meet the demand for consumption.

To top the yield potential of the recommended varieties, large amount of nutrient should be available to the plant. Nutrients should be adjusted to the yield level potential of the variety. These nutrients, though varying with climate, soil properties, management and variety, reflect the gap between the ideal fertilizer requirement of corn to produce high yield and the actual amount of fertilizer applied by corn farmers. The final amount of fertilizer to be applied is determined principally by the nutrient available on the soil. When the amount of available nutrient is low, fertilizer must be added. According to PCARRD (1981) a knowledge of the efficiency of nutrient uptake helps determine the most effective rates of fertilizers to be applied to plants. Boron is one of the nutrient elements essential to crop growth. However, its application varies from season to season and the actual amount required varies according to crop species. Application of boron is significant to the growth and yield of corn because it inhibits the formation of starch by combining the active site of phosphorylates. In this manner, boron functions protectively by preventing the excessive polymerization of sugar synthesis. According to Tisdale and Nelson (1975) the bean plants grown without boron transpired less water less water than those grown with it. This reduction in transpiration would affect crop performance since it would decrease the rate of water absorption. It would cause abnormal morphology, higher sugar and hydrophilic colloid concentration to the boron deficient plants. Thus, it would be necessary to determine the right amount of boron fertilizer applied at appropriate growth stage that would optimize corn performance. Hence, this study was conducted.

The result of this study may serve as benchmark information on the basic effects of boron on the growth and yield of corn. It would also provide information on the appropriate levels of boron that can improve growth and yield of corn and the appropriate timing or schedule of boron application during the cropping period. The results may help in the conduct of more applied research by the Department of Agriculture, agricultural institutions and other agencies engaged in research, extension and production of corn. Furthermore, technologies generated from future applied research may improve corn productivity of areas with agro-climatic conditions similar to those in Tagbina, Surigao del Sur, the site of this basic research.

2. OBJECTIVES OF THE STUDY

The objectives of this study are:

1. To determine the effect of boron fertilizer levels, applied at the different growth stages, and
2. To determine the right level of boron fertilizer applied at an appropriate growth stage that could optimize corn growth and yield.

3. MATERIALS AND METHODS

3.1. Land Preparation

An area of 1,500 sq. m. was prepared thoroughly before planting. It was plowed, harrowed two times at weekly intervals to allow the seed to germinate and stubbles to decompose. After the last harrowing, four (4) blocks with sixteen (16) plots were prepared/ laid out.

3.2. Variety/Cultivar

The corn cultivar was a Pioneer variety. This was secured from certified growers in the locality.

3.3. Experimental Design and Field Layout

The experimental plots were laid out in two – factor Factorial Experiment in Randomized Complete Block Design (RCBD) with four (4) replications. It had a total area of 1,500 sq.m. divided into 64 treatment plots with an area of 18.0 sq.m. (6.0 m x 3.0 m.) per plot. An alleyway of 1 meter wide was provided between blocks to facilitate care and management of the plants. The treatments were designated as follows:

A. Levels of Application	B. Stages of Growth
T_1 = 0.8 kg boron/ha (Equal amount from vegetation to tasseling stage)	S_1 = Weekly Applications
T_2 = 1.6 kg boron/ha a. Vegetative Stage (early to Mid whorl 20-35 DAE)	S_2 = One Application
T_3 = 2.4 kg boron/ha a. Vegetative Stage (Early to Mid Whorl 20-35 DAE) b. Reproductive Stage (Tasseling Stage 45-55 DAE)	S_3 = Two Applications
T_4 = 3.3 kg boron/ha a. Vegetative Stage (Early to Mid Whorl 20-35 DAE) b. Reproductive Stage (Tasseling 45-55 DAE) c. Ten Days (2 weeks after tassel emergence)	S_4 = Three Applications

3.4. Cultural Practices

3.4.1. Planting and thinning

Pioneer variety of corn seed was sown at a distance of 75 x 20 cm at the rate of two seeds/ hills and covered by a thin layer of soil. The seedlings were thinned ten (10) days after sowing leaving one (1) plant/hill.

3.4.2. Fertilizer application

The result of soil analysis was the basis of determining the necessary NPK fertilizer applied to the experimental plots. The right amount of NPK fertilizer (40-40-60) was applied on the furrow during planting time at 158.34 kg/ha.

One of the micro-elements needed to attain optimum yield of corn is boron. Boron foliar fertilizer was therefore, applied in each treatment using knapsack sprayer.

3.4.3. Care and Management

All treatment plots were given uniform management practices against insect pest and diseases. Insect pests (borers, maggots and leafhoopers) were controlled by spraying the corn plants with either Decis, Cymbus or by whorl application of Furadan granules ten (10), twenty (20), thirty (30) and forty (40) days after planting.

Weeds were controlled by hand weeding three (3) weeks after planting and as the need arises.

3.4.4. Cultivation and Drainage

Twenty (20) days after planting, shallow cultivation or off-barring was applied to control weeds without damaging the plant during the process.

The remaining dosages (40 kg/ha) of recommended nitrogenous fertilizer (urea and ammonium sulfate) were applied in a straight band along the furrows (also called as a side dressing side dressing about six (6) cm on the side of the plant). The fertilizer was immediately covered after application by hilling -up at 8 cm. deep.

3.4.5. Harvesting

Corn ears were harvested when the plants reached their physiological maturity. This was indicated by the change in color of the leaves and husk from green to brown. And the appearance of the block layer at the base of the corn kernels. The ears were husked, shelled, dried and weighed to determine the yield.

3.5. Data Gathered

Agronomic characteristics:

3.5.1. Days from sowing to tasseling and silking

The number of days from sowing to tasseling and silking was determined when about 85% of the corn plants had tasseled and silked.

3.5.2. Days from sowing to maturity

The number of days from sowing to emergence until about 85% of the ears in each treatment plots that matured was counted and recorded.

3.5.3. Plant Height

This parameter was obtained by measuring the base of the plant to tip of the tassel from ten randomly selected sample plants in every treatment plot at 30, 45, and 60 days until the height never changed anymore.

3.5.4. Leaf Area Index (LAI)

This was obtained by measuring the length of the leaves of the sample plants from the base to the tip and the width on their broadest section. The LAI was computed using the formula:

$$\text{LAI} = \frac{\text{C.F.O}}{\begin{array}{c}\text{Ground Area} \\ (20 \times 75)\end{array}}$$

Where LAI = Leaf Area Index
L = Length
W = Width
C.F.O. = 0.75

3.6. Yield and Yield Components

3.6.1. Ear length

The length of the husked ears of the sample plants was measured from the base of the ears up to the top portion filled with grains.

3.6.2. Ear diameter

The middle portion of all sample ears was measured. The sum of diameters was divided by the number of sample ears to determine the average ear diameter.

3.6.3. Ear weight

All ear samples were weighed and divided by the number of samples to determine the average ear weight.

3.6.6. Grain yield

Grain yield was expressed in kilogram per hectare with moisture content of the kernels at 14% using the following formula:

$$\text{Grain Yield} = \frac{\text{Plot yield/kg}}{\text{1,000kg/ton}} \times \frac{\text{10,000 sq.m./ha}}{\text{Plot Area (Harvestable area)}} \times \frac{\text{100-MC}}{86}$$

The moisture content was determined by using a moisture meter.

4. RESULTS and DISCUSSION

4.1. Corn Height

4.1.1. 30 days after sowing

Corn heights measured thirty days after sowing as affected by the different levels of boron applied at different stages of growth are shown in Table 1. Generally, corn sprayed with 3.2 kg/ha of boron during the vegetative and reproductive stage, respectively was observed the tallest. The heights of corn sprayed weekly with 0.8 kg/h and 1.6 kg per hectare of boron were not significantly different from one another.

Results further showed a significant effect on the block. This was probably due to the unequal boron concentrations in the soils in the blocks, and exposure to light and other unexplained micro environmental factors.

Table 1. Plant heights (cm) of corn treated with varying boron levels applied at different growth stages measured 30 days after sowing

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (30 DAS)				MEAN 1/
	S_1	S_2	S_3	S_4	
0.8	71.25_{ef}	66.00_{bcd}	69.00_{cdef}	63.50_{bc}	67.44_{ab}
1.6	63.25_{bc}	61.75_{b}	79.25_{h}	68.25_{cdef}	68.12_{ab}
2.4	67.75_{bcde}	70.25_{def}	67.00_{bcd}	53.25_{a}	64.56_{a}
3.2	77.75_{gh}	74.00_{fg}	68.00_{cde}	66.00_{bcd}	71.44_{b}
MEAN 2/	70.00_{b}	68.00_{ab}	70.81_{b}	62.75_{a}	

1/ Means of boron level having similar letter are not significantly different at 1% level of significance, DMRT
2/ Means of stages of growth having similar letter are not significantly different at 5% Level of significance, DMRT
Means of treatment combination having similar letter are not significantly different at 1% level of significance, DMRT

4.1.2. 45 days after sowing

Table 2 shows that there was a significant combined effect of the different stages of plant growth and the different levels of boron fertilizer application on the plant height at 45 days after sowing. The tallest corn plants (160 cm) were those applied with 1.6 kg/ha of boron fertilizer at the vegetative and reproductive stage, respectively, while the shortest plants (125.75 cm) were those applied weekly with 0.8 kg/ha of boron fertilizer.

4.1.3. 60 days after sowing

Table 3 indicates a significant interaction effect between the levels of boron fertilizer of corn and the different stages of plant growth application. It was observed that the combined effects of 2.4 kg/ha of boron fertilizer applied once at the vegetative stage (S_2) produced the tallest plants with a mean height of 187.50 cm, while the shortest measurement was taken from plants treated with 3.2 kg/ha of boron fertilizer at S_3 (vegetative and reproductive stage). Further, it shows that at 60 DAS, the tallest corn plants (187.50 cm) were those treated with 2.4 kg of boron/ha applied at S_2 (one application at the vegetative stage: early to mid-whorl development 20-30 DAE). At the higher boron level of 3.2 kg/ha applied S_2 the corn height was shorter 186.75 cm suggesting that excessive boron concentration could have negatively affected corn height growth. This deleterious effect was further exacerbated when excessive boron level (3.2 kg of boron/ha) was applied two ties at S_3 producing the shortest corn at 165.25 cm at 60 DAS (Table 3). At three applications at S_4 the average corn height at all boron levels was also the lowest (174.69 cm).

Table 2. Number of days to tasseling (DAS) as affected by boron fertilizer levels applied in the different growth stages of the corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (45 DAS)				MEAN 1/
	S_1	S_2	S_3	S_4	
0.8	71.25_{ef}	66.00_{bcd}	69.00_{cdef}	63.50_{bc}	67.44_{ab}
1.6	63.25_{bc}	61.75_{b}	79.25_{h}	68.25_{cdef}	68.12_{ab}
2.4	67.75_{bcde}	70.25_{def}	67.00_{bcd}	53.25_{a}	64.56_{a}
3.2	77.75_{gh}	74.00_{fg}	68.00_{cde}	66.00_{bcd}	71.44_{b}
MEAN 2/	70.00_{b}	68.00_{ab}	70.81_{b}	62.75_{a}	

Means of treatment combination having similar letter are not significantly different at 1% level of significance, DMRT

Table 3. Plant heights (cm) of corn treated with varying boron levels applied at different growth stages measured 60 days after sowing

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (60 DAS)				MEAN 1/
	S_1	S_2	S_3	S_4	
0.8	125.75_{a}	128.25_{ab}	137.25_{ef}	135.50_{de}	131.69_{a}
1.6	131.00_{bcd}	134.50_{cde}	160.00_{g}	139.00_{ef}	141.12_{c}
2.4	134.75_{cde}	139.00_{ef}	139.25_{ef}	129.50_{abc}	135.62_{ab}
3.2	142.25_{f}	140.00_{ef}	131.25_{bcd}	135.00_{de}	137.12_{bc}
MEAN 2/	133.44_{a}	135.44_{a}	141.94_{b}	134.75_{a}	

1/ Means of boron level having similar letter are not significantly different at 1% level of significance, DMRT
2/ Means of stages of growth having similar letter are not significantly different at 5% Level of significance, DMRT
Means of treatment combination having similar letter are not significantly different at 1% level of significance, DMRT

Table 4. Number of days to tasseling (DAT) as affected by boron fertilizer levels applied at the different growth stages of corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (cm) S_1	S_2	S_3	S_4	MEAN 1/
0.8	54.25	52.75	55.25	54.50	54.19_b
1.6	53.50	53.25	54.50	54.50	53.81_a
2.4	54.00	53.75	53.25	54.75	54.19_b
3.2	53.00	54.00	56.50	55.50	54.75_b
MEAN	53.69_b	53.44a	55.00_b	54.81_b	

Means having similar letter are not significantly different at 5 % level of significance, DMRT

Table 5. Number of days to silking (DAS) as affected by boron fertilizer levels applied at the different growth stages of corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (cm) S_1	S_2	S_3	S_4	MEAN 1/
0.8	57.75_{cd}	58.25_{cde}	58.25_{cde}	58.50_{cde}	58.19_{ab}
1.6	57.75_{cd}	58.25_{cde}	57.00_{bcd}	57.75_{cd}	57.69_{ab}
2.4	56.75_{abc}	55.25_{ab}	57.75_{cd}	59.00_{def}	57.69_a
3.2	55.00a	58.25_{cde}	60.75_f	60.25_{ef}	58.56_b
MEAN	56.81	57.50	58.44	58.88	

Means having similar letter are not significantly different at 5 % level of significance, DMRT

4.2. Days to Tasseling

ANOVA Test showed that the number of days to tasseling after sowing of corn was not affected by the combined effects of all stages of growth and all levels of boron fertilizer.

However, Table 4 shows that the boron level of 1.6 kg/ha significantly induced early tasseling of corn with an average of 53.81 days when applied at all stages of growth tested in this study. Specifically, the growth stage where early tasseling generally occurred with an average of 53.44 days for all boron levels was at S_2 (one application at the vegetative stage).

The results suggested that none of the specific treatment combinations (T_1 x S_1 etc.) had induced early tasseling of corn thus the right boron level and growth stage combination could not be ascertained.

4.3. Days to Silking

There were significant combined effects of the different stage of the plant growth and the levels of boron fertilizer application on the days to silking as revealed by ANOVA. On the other hand, only the growth variable did not affect the number of days to silking. The earliest silking period was at 55 days after sowing as demonstrated by plants applied with 3.2 kg/ha of boron fertilizer at weekly application, while the longest silking period was shown by plants treated with 3.2 kg per hectare of boron fertilizer at vegetative and reproductive stages with a mean of 60 days after sowing (Table 5).

A difference of five (5) days to silking is advantageous to corn plants considering that exposure of corn to unfavorable environmental condition was shortened for five days. The effect of weekly application of boron fertilizer on increasing the rate of water absorption of plants causing a cooling effect could have induced early silking. This is based on the findings of Tisdale and Nelson (1975) that plants grown without boron have lower rate of water absorption causing abnormal morphology.

4.4. Leaf Area Index

Table 6 shows the average leaf area index (LAI) of corn. In general, the stages growth influenced the enlargement of LAI, and plants applied with 1.6 kg/ha of boron fertilizer have significant bigger LAI than those applied with 0.8, 2.4 and 3.2 kg/ha of boron fertilizer. It was observed that the combination of two applications such as vegetative and productive stages of growth did not differ significantly from each other.

Results further show significant interaction effect among the varying stages of growth and levels of boron fertilizer. It was observed that the combination of two applications such as vegetative and reproductive stage (S_3) with 1.6 kg/ha of boron fertilizer application (T_3) gave the smallest leaf area index with a mean of 0.25 cm.

These significant effects on increased leaf area indices of corn have positive influence on the rate of photosynthesis as suggested by the findings of Shorrocks and Phil (1997) that boron induces complete leaf expansion. Leaf expansion provides an opportunity for the plants to have enough food which is essential for proper seed set and fruit development, thereby higher yield probability.

Table 6 Average leaf area index (LAI) cm as affected by boron fertilizer levels applied in the different growth stages of the corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (cm)				MEAN
	S_1	S_2	S_3	S_4	1 /
0.8	0.28_{cd}	0.28_{cde}	0.27_{bc}	0.27_{bc}	0.27_{a}
1.6	0.28_{cd}	0.30_{ef}	0.32_{f}	0.29_{de}	0.30_{b}
2.4	0.27_{bc}	0.25_{a}	0.26_{ab}	0.25_{a}	0.26_{a}
3.2	0.27_{bc}	0.26_{bc}	0.26_{ab}	0.28_{ab}	0.27_{a}
MEAN	0.28	0.27	0.28	0.27	

Means having similar letter are not significantly different at 5 % level of significance, DMRT

Table 7. Ear length (cm) as affected by boron fertilizer levels applied in the different growth stages of the corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (cm)				MEAN
	S_1	S_2	S_3	S_4	1 /
0.8	14.47_{abc}	14.74_{bc}	14.08_{ab}	15.06_{cd}	14.49_{ab}
1.6	15.03_{cd}	15.02_{c}	15.92_{d}	14.40_{abc}	15.09_{b}
2.4	13.80_{a}	15.07_{cd}	14.84_{bc}	15.23_{cd}	14.74_{ab}
3.2	14.03_{ab}	14.51_{abc}	14.84_{bc}	14.56_{abc}	14.48_{a}
MEAN	14.33	14.84	14.92	14.81	

1/ Means of boron level having similar letter are not significantly different at 1% level of significance, DMRT
Means of treatment combination having similar letter are not significantly different at 1% level of significance, DMRT

4.5. Ear Length

Ear lengths (cm) of corn evaluated at maturity presented in Table 7. Regardless of the different growth stages of corn, plants sprayed with 1.6 kg/ha of boron fertilizer produced the longest ear with a mean of 15.09 cm while the short length of the ear was produced by plants sprayed with 3.2 kg/ha of boron fertilizer. Ear lengths of plants applied weekly, at vegetative and reproductive stages; three applications at vegetative, reproductive stage and ten days after tassel emergence and one application at vegetative stage only did not differ significantly from each other.

The results further revealed significant interaction effects between the different stages of growth and levels of boron fertilizer on the length of corn ears. Plants sprayed twice during vegetative and reproductive stages with 1.6 kg/ha of boron fertilizer produced the longest ear with a mean of 15.92 cm. The shortest ears were produced by the plants sprayed weekly with 2.4 kg/ha of boron fertilizer with a mean of 13.80 cm.

These significant effects on increased ear length of corn could have resulted in a bigger space for kernel development which could have increased corn yield.

4.6. Ear Diameter

Table 8 indicates the ear diameter (cm) of corn evaluated at maturity. The biggest ear diameter was obtained in plants treated with 3.2 kg per hectare of boron fertilizer at weekly interval.

It was observed that the different stages of growth application had no significant effect on the diameter of corn ear. However, there was a significant difference of corn ear diameter among the different levels of boron fertilizer. Corn treated with 1.6 kg/ha of boron fertilizer produced the biggest ear diameter with a mean 4.63 cm. However, it did not significantly differ from plant applied with 2.4 and 3.2 kg/ha of boron fertilizer. T_1 (0.8 kg/ha of boron fertilizer) gave the smallest diameter.

The results suggested another beneficial effect of applying different levels of boron fertilizer at different stages of growth resulting in proper development of kernel during the reproductive stage of corn plant. This result conformed with the findings of Stoyanov (1985) that the application of boron improves the pollination of sunflowers and a fuller seed set is achieved in the middle of the head.

Table 8. Ear diameter (cm) as affected by boron fertilizer levels applied in the different growth stages of the corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (cm)				MEAN 1/
	S_1	S_2	S_3	S_4	
0.8	4.62_{cde}	4.58_{bcd}	4.45_{a}	4.62_{cde}	4.57_{a}
1.6	4.50_{ab}	4.65_{de}	4.80_{f}	4.58_{bcd}	4.63_{b}
2.4	4.52_{abc}	4.68_{de}	4.65_{de}	4.65_{de}	4.62_{b}
3.2	4.45_{a}	4.65_{de}	4.60_{cd}	4.72_{ef}	4.61_{b}
MEAN	4.53	4.64	4.62	4.65	

1/ Means of boron level having similar letter are not significantly different at 5% level of significance, DMRT
Means of treatment combination having similar letter are not significantly different at 1% level of significance, DMRT

4.7. Ear weight

Table 9 presents the weight of ten corn ears. Weight of ears varied significantly from 1.68 to 1.78 kilograms among boron levels.

On the other hand, ear weights at different growth stages ranged from 1.64 to 1.78 kilograms but they did not differ from each other. Results further illustrate significant interaction effect among the different stages of growth and levels of boron fertilizer on ear weights of corn plants. It was observed that the combination of two applications (S_3) with 1.6 kg/ha of boron fertilizer produced the heaviest ear weight with a mean of 1.95 kilograms while plants treated with 0.8 kg/ha of boron fertilizer at weekly interval gave the lighter corn ear with a mean of 1.57 kilograms.

The corresponding increase in the weight of the ear was due to the favorable effect of the right level of boron fertilizer applied at the proper time/stage of growth. Continued application of boron fertilizer up to the reproductive stage (60 days after emergence) has provided adequate supply of the element which is essential for proper seed set and kernel development.

4.9. Grain Yield

There is significant interaction effects among the different the different levels of boron fertilizer applied at the different stages of growth.

Result showed that 1.6 kg/ha of boron fertilizer applied three times (at vegetative, reproductive stage and ten days after tassel emergence) produced the highest grain yield of 0.78 t/ha while 2.4 kg/ha of boron fertilizer sprayed weekly produced the lowest grain yield of corn of 0.56 t/ha. The significant yield increase at three applications (vegetative, reproductive and ten days after tassel emergence) 0f 1.6 kg/ha of boron fertilizer is an indication that continued supply of the right amount of boron resulted in improved growth of corn. Improved growth resulted in bigger ear diameter, longer ear length, heavy ear weight and appreciable grain yield. Furthermore, results favorably endorsed the findings of Stoyanov (1985) that the application of boron improves pollination, and a fuller seed set is achieved in the middle of corn ear, increasing the yield of plants and improving the quality of corn kernels thus, high yield of corn was obtained.

5. SUMMARY & CONCLUSION

The results are summarized as follows:

1. Response of corn to different levels of boron fertilizer, applied at the different stages of plant growth, was observed highly significant

Table 9. Ear weight (kg) as affected by boron fertilizer levels applied in the different growth stages of the corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (cm)				MEAN 1 /
	S_1	S_2	S_3	S_4	
0.8	1.57_{a}	1.66_{abc}	1.60_{ab}	1.91_{de}	1.68_{a}
1.6	1.73_{abcde}	1.80_{abcde}	1.95_{e}	1.65_{abc}	1.78_{b}
2.4	1.64_{abc}	1.79_{abcde}	1.86_{cde}	1.86_{bcde}	1.78_{b}
3.2	1.62_{ab}	1.72_{abcde}	1.70_{abcd}	1.74_{abcde}	1.70_{a}
MEAN	1.64	1.74	1.78	1.78	

Means of treatment combination having similar letter are not significantly different at 1% level of significance, DMRT

Table 10. Grain yield (ton/ha) as affected by boron fertilizer levels applied at the different growth stages of corn plant

BORON LEVEL (Kg/ha)	STAGES OF GROWTH (kg)				MEAN 1/
	S_1	S_2	S_3	S_4	
0.8	0.59_{abc}	0.59_{abc}	0.57_{ab}	0.68_{de}	0.61_{a}
1.6	0.58_{abc}	0.63_{bcd}	0.76_{ef}	0.78_{f}	0.69_{b}
2.4	0.56_{a}	0.68_{de}	0.64_{cd}	0.68_{de}	0.64_{ab}
3.2	0.58_{abc}	0.62_{abcd}	0.62_{abcd}	0.63_{bcd}	0.61_{a}
MEAN	0.58_{a}	0.63_{b}	0.65_{bc}	0.69_{c}	

Means having similar letter are not significantly different at 1 % level of significance, DMRT

on grain yield. A concentration of 1.6 kg/ha of boron fertilizer produced the best measure in most of the parameters when applied at S_3 (vegetative, reproductive stage and ten days after tassel emergence).

2. Significant interaction effects among different levels of boron fertilizer applied at the different stages of plant growth were observed to have favorably influenced the plant height at 30, 45 and 60 days after sowing, number of days after sowing, number of days to silking, leaf area index, ear length, ear diameter, ear weight and grain yield but showed no effect on number of days to tasseling.

3. Different levels of boron fertilizer significantly influenced plant height at 30, 45 and 60 days after sowing, number of days to tasseling, number of days to silking, leaf area index, ear length, ear diameter and grain yield. All parameters used to determine the effects of boron fertilizer level (as applied at the different growth stages on the growth and yield of corn). were affected.

4. Treatment B or application at different stages of plant growth showed no effect on plant height 60 days after sowing, number of days to silking, leaf area index, ear length, ear diameter and ear weight. Moreover, three foliar applications of 1.6 kg/ha of boron fertilizer at the vegetative, reproductive stage and ten days after tassel emergence, respectively, appeared to be appropriate treatment combination to optimize corn growth and yield.

6. RECOMMENDATIONS

Similar studies shall be conducted in other localities to determine the actual effects of boron on corn growth and yield. Since this study was conducted during rainy days/ seasons, a comparative study during dry season is also recommended. This study will serve as benchmark information for conducting applied researches and guide corn growers in increasing their production.

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