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Efficacy of Herbicides as Plant Growth Regulator on Productivity of Maize with Special Aspect of Baby Corn

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ABSTRACT

The experiments were conducted on sandy clay loam soils during Rabi (November to March) and Kharif (June to September) season of 2013 to study the effect of herbicides at low concentrations as growth regulators on productivity of maize. The experiment was laid out in randomized complete block design with three herbicides at different concentrations (2, 4-D@50 ppm, atrazine@100 ppm and glyphosate @5 ppm) along with control. The results were indicative that low herbicide concentrations promoted that growth and yield attributes in maize. Application of 2, 4-D@50 ppm significantly increased growth parameters (plant height, number of green leaves plant^{-1}, LAI and DMP) and yield attributes *viz.* length of cob and corn, weight of cob and corn, whereas significantly reduced cob-corn ratio, in comparison with Atrazine@100ppm and Glyphosate@5ppm. Phenological stages such as days to tassel emergence and cob initiation and yield attributes viz. width of cob and corn, numbers of cobs plant^{-1}, No. of cobs ha^{-1} were not significantly influenced by the herbicides. Increased growth parameters (LAI and DMP), yield attributes (length of cob and corn, weight of cob and corn) due to 2,4-D@50ppm led to higher green cob yield (14.2% over control) and green fodder yield of baby corn over control.

KEY WORDS: 2, 4-D, Atrazine, Maize, Glyphosate, Herbicide and Weeds.

INTRODUCTION

Maize (*Zea mays* L.) is the world's third leading cereal crop after wheat and rice. It is belong to family *Poaceae* and is one of the most important cereal crops in the world agricultural economy both as food and fodder crop and is regarded as queen of cereals. Maize grains are used for human consumption, feed for poultry and livestock, for extraction of edible oil and also for starch and glucose industry. It is called as a miracle crop with very high yield potential. It occupies an important position in the world economy and trade as a food, feed and industrial grain crop (Azizi *et al*., 2012). In India, maize is grown over an area of 8.33 million ha with an annual production of about 16.68 million tones and an average productivity of about 2015 kg per ha (Mehmeti *et al*., 2011). Maize is classified in to different groups or types based on the endosperm of kernels among which baby corn is grown for vegetable purpose. In the world it accounts for 8 and 25 per cent of the area and production of cereals, respectively. This venture proved enormously successfully in countries like Thailand, Taiwan, Srilanka and Myanmar. The countries like Guatemala, Zambia, Zimbabwe and South Africa have also started cultivation. Now, Thailand and China are the world leaders in baby corn production. It is widely accepted and habituated as a cereal vegetable in USA, Europe and in some Asian countries. In India, cultivation of baby corn is of recent development. Its cultivation is increasing in Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Karnataka and Andhra Pradesh (Dangwal *et al.*, 2010).

Baby corn is a delicious and nutritive vegetable and it is consumed as a natural food. It is very tasty, sweet and easy to consume because of its tenderness and sweetness with nutritive value addition. It provides carbohydrates, protein, fat, sugar, minerals and vitamins in palatable, wholesome, hygienic and digestible form. It is rich in phosphorus content (86 mg/100 g edible portion in comparison to 21 to 57 mg phosphorus content in other commonly used vegetables). It is a low calorie vegetable having higher fiber content without cholesterol. Besides nutritive advantage, it is also free from residual effect of pesticides as it is harvested within a week of tassel emergence and the young cob is wrapped up tightly with husk and well protected from insects and pests (Demjanova *et. al.,* 2007). Breeding programmes are currently being taken up under All India Co–ordinate Research Project on maize improvement at Kullu valley in Himachal Pradesh and Karimnagar and Hyderabad in Andhra Pardesh to identify and develop hybrids and high yielding varieties of baby corn. It is believed that agronomy of baby corn is not much different from that of regular maize crop. However, the stages and purpose of harvest are different in baby corn.

Hence it is necessary to develop specific cultivation practices for baby corn production. Depending on agro–climatic conditions, 3 - 4 crops of baby corn can be grown in a year realizing higher profit per hectare per season. It is a fact that the economic yield is the result of crop architecture, which is determined by the plant geometry. In order to realize maximum yield of good quality baby corn, it is important to maintain optimum plant population with suitable crop geometry.

Despite its great importance in Indian agriculture as well as export potentiality, a very little work has been done on baby corn in India (Abdullah *et al.,* 2007). In the past, the practice has been to use any genotype of maize for the cultivation of baby corn and detailed studies have not been conducted to identify and/or develop varieties suitable for baby corn. In India, only few single cross hybrids have been found to be preferred for baby corn cultivation (HM-4, HQPM-1, PEHM-2 and Kanak etc.). All these hybrids were originally developed for grain purpose and they are considered for baby corn usage on account of some characteristic features. At present, exclusive and specific single cross baby corn hybrids are not available under public domain. Developing baby corn cultivars/hybrids specifically adaptable to Indian conditions might be one of the approaches, especially for fulfilling short and/or medium term goals. Here also emphasis needs to be given on early maturity, considering the fact that many crops can be taken under the Indian conditions due to reasonably favorable weather throughout the year in most of the states. Early maturity is also an important factor for determining comparative advantage especially in relation to other vegetables in specific season.

Baby corn production being a very recent development, cultivation practices need to be standardized before it finds a prominent place in most of the intensive cropping systems due to its short duration nature. Inadequate spacing leads to low productivity along with poor quality. Though spacing requirement of gain maize has been standardized, the information on influence of spacing on yield and quality of baby corn hybrids and composites is lacking. Corn being an exhaustive crop, its requirement for fertilizers especially for nitrogen is prominent. Nitrogen is essential constituent of chlorophyll, protoplasm and enzymes. Further, it governs utilization of phosphorus and potassium. It is an important factor for better vegetative growth and boosting up the yield of cereals (Khan and Haq, 2004). The review indicates that baby corn yield increased with increasing levels of nitrogen application.

Baby corn cultivation being a relatively new practice in India, requires the development of suitable production technology in realizing higher baby corn yield and monetary returns before it could be popularized among maize growers. Baby corn crop owing to its more profitability than grain maize may be helpful in raising the income of the farmers (Dangwal *et al.*, 2010). Since genotypes, spacing and fertilizers are most important factors in agriculture and the information on these interaction effects with other inputs is rather limited.

Yield in maize was reduced as much 86 percent when weeds were not controlled. Therefore, weed control plays an important role in maize production ensuring an acceptable yield. Weed control in maize is carried out mainly by mechanical and chemical methods, but herbicide use is increasing, along with increases in growing areas and production costs.

Herbicides at low concentrations are used as growth regulators. 2, 4-D belongs to the group of phenoxy herbicides, its activity at low concentration is similar to the Indole Acetic Acid (IAA). The stimulatory effect of 2, 4-D was proven in wheat, beans, potato, sugarcane and soybean (Reddy and Reddy, 1999). Triazines have favorable effect, on crop plants at sub-lethal doses. Atrazine increased total nitrogen, protein content and yield of sweet corn and physiological process in sorghum (Sairam *et al.*, 1988). Glyphosate was tried newly. However, these were no reports on foliar spray of these herbicides on maize production. Thus, the experiment was conducted to study the effect of 2, 4-D and atrazine along with glyphosate at different concentrations on growth and yield of baby corn.

The present study was carryout on favorable effect of herbicides on maize crop at high dose of concentration not suitable and sub-lethal doses best for all growth regulators. Genotypes to plants density and fertilizer levels" was carried out at Agricultural farm of Chaudhary Chhotu Ram Post Graduate College, Muzaffarnagar, Uttar Pradesh.

MATERIALS AND METHODS

A field experiment was conducted at the Chaudhay Chhotu Ram (PG) Collage, Muzaffarnagar during Rabi (October-March) and kharif (June – September) season of 2013. The experiment was conducted (Agricultural farm of railway crossing side, block-A) at CCR (PG) Collage, Muzaffarnagar. The soil of the experiment aria was sandy clay loam with alkaline pH; low in organic carbon (0.34 and 0.32%) and available N (210.4 and 233.4 kg ha^{-1}), medium in available P (12.4 and 11.8 kg ha^{-1}) and high in available K (438.6 and 414.6 kg ha^{-1}) during late Rabi and kharif 2013 seasons, respectively. Baby corn variety Surya (Hybrid) with field duration of 65-70 days was used in the trial.

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The experiment consist of six treatments (Table 1) with three herbicides (2, 4–D, atrazine and glyphosate) each with four varied concentration for along with water spray (control) and no spray (absolute control). The seed were pre-treated with fungicide (Thriam @ 4 g kg^{-1}seeds) and bio-fertilizer (Azospirillum@600 g ha^{-1} seeds) and sown at a spacing 45×25 cm. The recommended fertilizers (150:60:40NPK ha^{-1}) were applied in the form in the Urea (N), single super phosphate (P) and muriate of potash (K). Full dose of phosphorus and half of nitrogen and potassium were applied at the time of sowing. Remaining of 50% of nitrogen and potassium were applied at 25 Days After Sowing (DAS) as top dressing. Three herbicides selected with different concentration in the (Fig.1, 2&3). These herbicides 2, 4–D @20-50ppm, atrazine@70-100 ppm and glyphosate@05-20ppm were prepared by diluting with distilled water and sprayed in evening hours by hand operated sprayer at 25 and 45DAS. Two-hand weddings (20 and 40 DAS) were done to check the weeds. Need based plant protection measures were carried out timely. Detaselling was done before the emergence of tassel from the flag leaf. The cobs were harvested after 2-3 cm length of silk emergence.

For recording various biometric observations on baby corn, from each net plot a sample consisting of five plants were selected at random and tagged. From the tagged plants, observations on plant height, number of green leaves $plant^{-1}$, Leaf Area Index (LAI) and Dry Matter Production (DMP) at harvest have been recorded. Plant height was measured from ground level to the tip of flag leaf. Number of green leaves $plant^{-1}$ was recorded by counting the number of fully opened green leaves borne on main stem of a plant. Dried and yellow leaves are not considered for counting. The collected leaves from the sample plants were taken of the laboratory and the leaf area was measured by using leaf are meter (LICOR Model 3100). From the leaf area, LAI was calculated.

$$\text{Leaf Area Index} = \frac{\text{leaf area plant}^{-1} \times 100}{\text{Ground area occupied plant}^{-1}}$$

DMP was obtained by drying the plant sample at 70°C till the constant weight was attained. A day taken to the tassel and cob emergence was noted. The yield parameters *viz.* Number of cobs $plant^{-1}$, length, width and weight of green cob, length, width and weight of corn were measured from the sampling plants. Green cob to corn ratio was calculated by dividing the weight of green cobs with weight of corn. Number of cobs (lakh ha^{-1}) was obtained by multiplying the number of plants ha^{-1} and number of cobs plant^{-1}. Green cob yield from net plot was harvested alternate days, weighed and expressed in kg ha^{-1}. The data was subjected to statistical analysis (Gomez and Gomez, 1984). Green cob and folder yields were pooled and analyzed

RESULTS AND DISCUSSION

Effect of three selected herbicides on baby corn:

Three herbicides were selected for growth effect on baby corn with different aspect *viz.* leaf width, leaf height, total height of plant (cm) and total number of leaf each plant. Herbicides 2, 4-D, atrazine and glyphosate were used of different concentration. Most effective concentration was applied for further studies. The results recorded in the (Fig.1) revealed that glyphosate were found most effective at concentration 5ppm followed by 10ppm for maximum growth aspects as such as total number of leaf, width of leaf, height of leaf and height of each plant (cm). In case of atrazine, result (Fig.2) revealed that most effective concentration was at 100ppm followed by 90 ppm for maximum growth aspects as such as total number of leaf, width of leaf, height of leaf and height of each plant (cm) and 2, 4-D most effective at 50ppm concentration followed by 40ppm for maximum growth aspects as such as total number of leaf, width of leaf, height of leaf and height of each plant (cm).

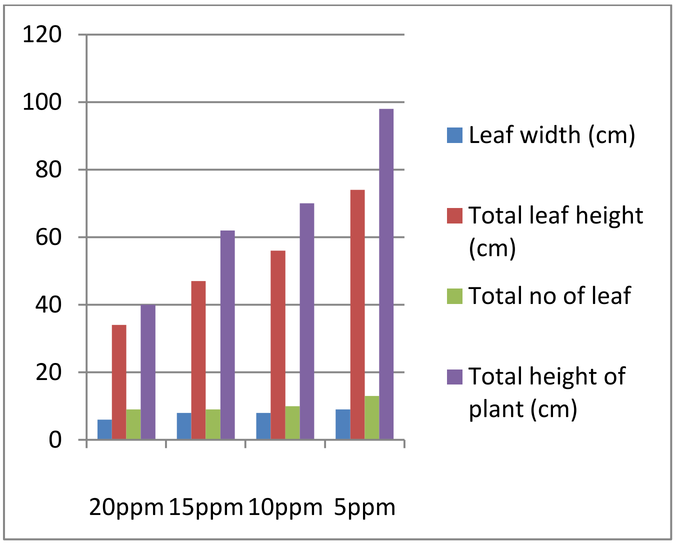

Fig. 1: Growth effects of different concentration of glyphosate

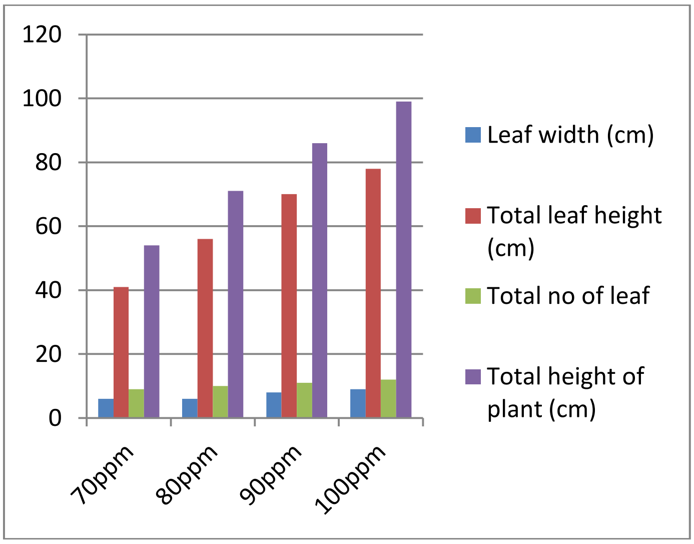

Fig. 2: Growth effects of different concentration of atrazine

Growth Characters:

Effect of herbicides at low concentrations on growth of baby corn was significant (Table 1).

Table 1: Effect of herbicides as growth regulators on growth parameters of maize (pooled mean of two seasons)

Treatments	Plant Height in (cm)	No of green leaves plant^{-1}	Leaf Area Index (LAI)	Dry Matter Production (DMP) (kg ha^{-1})	Days to first tasseling	Days to first cob initiation
2,4-D @50 ppm	189.0	10.8	3.25	8466	54.6	58.0
Atrazine @100 ppm	175.2	9.0	2.88	7724	53.8	56.0
Glyphosate @5 ppm	176.4	9.1	2.96	7678	53.4	57.2
control	174.6	9.0	2.88	7512	52.3	54.6
Absolute control	173.2	9.0	2.84	7636	54.0	56.4
SED	4.8	0.42	0.16	226	2.6	2.8
CD at 5%	9.8	0.86	0.28	458	N	N

Plant height, No of green leaves, LAI and DMP were not varied at 45 DAS (data not shown) whereas at harvest there was significant difference among the treatments during both the seasons. Foliar spray of 2, 4-D @50ppm produced taller plants (188.0cm), retained more No. of green leaves plant (10.4), Maximum LAI (3.26) and more DMP (8368 kg ha) at harvest than rest of the treatments. There was no significant difference among atrazine, glyphosate 2, 4-D@25ppm and control and absolute control. Herbicides show stimulatory effects on some crops at sub lethal doses (Reddy and Reddy, 1999). Phenoxy herbicides have similar action of IAA, which were active at the meristematic tissues causing increased metabolic activities and consequently higher yield in crops (Reddy and Reddy, 1999). Higher growth characters in the 2, 4-D@50ppm treatment might be due to higher chlorophyll content, photosynthetic rate, stomatal conductance and nitrate reeducates activity at the different growth stages of the crop over other treatments and control. These results are in line with Panwar and Elanchezhian (1998). Elanchezhian and Panwar (1997) also reported that 2, 4-D induced the root structure and enhanced the nitrogenous activity in wheat. This might have influenced the chlorophyll content and in turn increased the retention of more leaves, increased, LAI and DMP in baby corn. Phenological stages such as days to tassel emergence and cob initiation were not influenced by the herbicides at these low concentrations.

Yield Attributes:

Herbicides spray at 25 and 45 DAS markedly influenced the yield components (length of cob and corn, weight of cob and corn, cob-corn ration) of baby corn during both the seasons (Table 2).

Table 2: Influence of herbicides as growth regulators on yield attributes and yield of maize (pooled of two seasons)

Treatments	No of cobs/plant	Length of cob (cm)	Width of cobs (cm)	Weight of cob (gm)	Length of corn (cm)	Width of corn (cm)
2,4-D @50 ppm	2.8	24.6	3.54	47.8	10.8	1.74
Atrazine @100 ppm	2.5	21.8	3.45	43.6	9.52	1.62
Glyphosate @5 ppm	2.6	21.4	3.42	43.1	9.32	1.58
control	2.3	20.8	3.36	42.2	8.98	1.68
Absolute control	2.6	21.6	3.36	42.4	8.99	1.64
SED	0.16	0.99	0.17	1.42	0.44	0.09
CD at 5%	NS	2.08	NS	2.82	0.96	NS

Foliar spray of 2, 4-D@50ppm produced longer and heavier cobs (24.5 cm and 47.6g) and corns (10.7cm and 11.3 g, respectively), and also reduced the cob-corn ratio (4.2) as followed by 2,4-D@40ppm, 2,4-D@30ppm, 2,4-D@20ppm, atrazine@100ppm followed by atrazine@90ppm, atrazine@80ppm, atrazine@70ppm and glyphosate@5ppm followed by glyphosate@10ppm, glyphosate@15ppm and glyphosate@20ppm also herbicides different concentration sprays. Number of cobs plant, number of cobs (lakh ha), width of cob and corn were also not influenced significantly by the foliar spray of sub lethal dose of herbicides. The possible reason for higher yield attributes with 2, 4-D @ 50 ppm application was the higher number of green leaves, LAI and DMP up to harvest, which would have influenced the photosynthetic activity and in turn increased the yield attributes of baby corn. Length of cob and corn had increased with 2, 4 D@50 ppm which increased the weight of cob and corn. Economic part (corn) was increased with 2, 4-D@50 ppm by reduced cob-corn ratio. Increased yield attributes might be due to the higher growth parameter like more number of green leaves. LAI and DMP. Similar findings have been reported in wheat (Panwar and Elanchezhian, 1998; Nehra and Hooda, 1998), sorghum (Sairam *et al.*, 1988) and oats (Sairam *et al.*, 1986). Elanchezhian and Panwar (1997) opined that 2, 4-D foliar spray increased the amylase activity, root number and shoot dry weight, which in turn increased the yield attributes of wheat.

Yield:

There was a sign that foliar spray of herbicides at low concentrations influenced the green cob and green fodder yield of baby corn (Table 2). Foliar spray of 2, 4-D@50 ppm registered the highest green cob yield (7108 kg ha) and the increase was 14.2% over control. Similarly, application of 2, 4-D@50ppm pronounced green fodder yield in both seasons. Whereas, low concentration of 2, 4-D@ (25ppm) and also sub lethal doses of atrazine and glyphosate failed to increase the green cob and green fodder yields of baby corn. It might be due to increased growth and yield parameters, which in turn increased the green cob yield. Higher growth parameter such as plant height LAI and DMP and also retention of more green leaves contributed to higher green fodder yield. Panwar and Elancheznian (1998) reported that 2, 4-D application increased N rise activity, Chlorophyll content, which increased the yield attributes and ultimately increases wheat yield. Higher grain yield due to 2, 4-D was also reported in wheat (Elanchezhian and Panwar, 1997; Nehra and Hooda, 1998; Singh and Sharma, 1984). Increased nitrogenase and N Rase activities and mineral uptake was also reported in several crops (Kennedy and Tehan, 1992; Ridge *et al*., 1992; Panwar, 1993). Increase yield in oats (Sairam *et al*., 1986) and sorghum (Sairam *et al*., 1988) was also reported.

The three selective herbicides were used selected concentration of atrazine, glyphosate and 2, 4-D with control for propose of all aspects of growth of maize/ baby corn variety of surya in Muzaffarnagar. The results recorded in the (Fig.4) revealed that maximum growth of each plant *viz.* width of leaf, height of each leaf, height of plant (cm) and total numbers of leaf each plant of leaf with total production of maize were found most effective herbicides 2, 4-D followed by glyphosate.

The Present study suggests that spraying of 2, 4-D@50ppm at 25 and 45 DAS positively enhanced the growth and yield attributes, green cob and green fodder yields of baby corn. If the impact will be proven from further research, this practice will increase the productivity of baby corn and consequently the farmers' income. Undoubtedly, since just one variety was used, results of present study have limited value and further similar study is needed to confirm their validity.

Table 3: Influence of herbicides as growth regulators on yield attributes and yield of maize (pooled of two seasons

Treatments	Weight of com (cm)	Cob-com ratio	Maize Lakh ha^{-1}	Maize yield (kg ha^{-1})	Fodder yield (t ha^{-1})
2,4-D @50	11.8	4.6	2.36	7206	30.6

ppm					
Atrazine @100 ppm	9.9	4.8	2.16	6500	28.0
Glyphosate @5 ppm	9.6	4.8	2.16	6416	27.6
control	9.4	4.6	2.16	6324	26.4
Absolute control	9.4	4.6	2.16	6291	26.4
SED	0.16	0.11	0.11	266	1.4
CD at 5%	0.32	0.24	NS	538	2.8

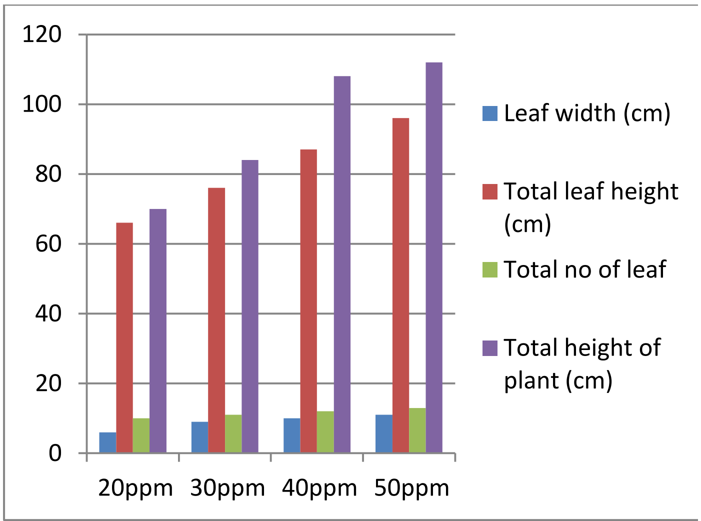

Fig. 3: Growth effects of different concentration of 2, 4-D

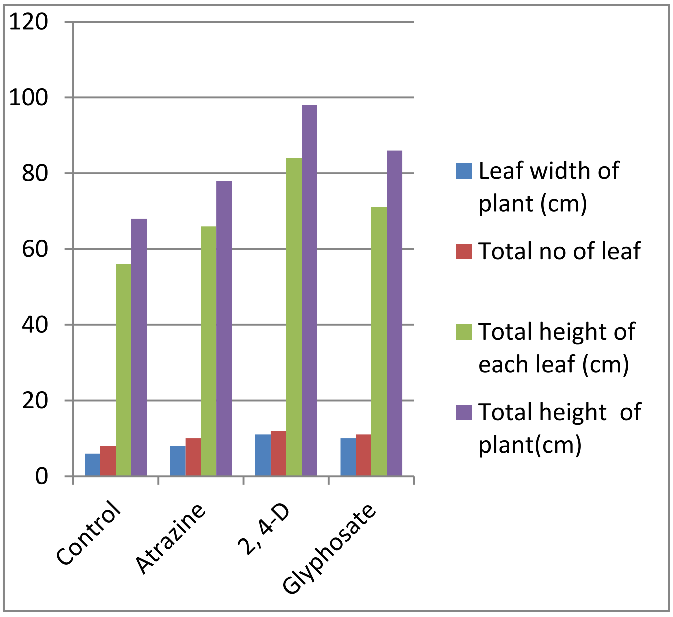

Fig. 4: Growth effects of maize on different aspects of plants

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