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Effect of gibberllic acid on growth, yield and economics of maize (Zea mays L.)

MAHENDER SINGH[1], NARENDRA KUMAWAT*, IS TOMAR[1], TS DUDWE, RK YADAV[1] AND YOGESH KUMAR SAHU[1]

AICRP on Maize, Zonal Agricultural Research Station, Jhabua, Madhya Pradesh, India

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ABSTRACT

The aim of present investigation was to study the effect of foliar application of gibberellic acid (Progibb 40% WSG) spraying at 4-5 leaves stage of the maize crop. Two field experiments were conducted during *kharif* 2014 and *rabi* 2014-15 at Research Farm, Zonal Agricultural Research Station, Jhabua. Seven treatments (T_1=20, T_2=30, T_3=40, T_4=50 T_5=60 gibberellic acid g/ha, Tricontanol 0.1%= 250 ml/ha and control) were tested in randomized block design with three replications. Results showed that variation in different doses of gibberellic acid had significant effect on growth character (plant height and silking) and yield attributes (no. of cobs/plant, cob length, no. of grains/cob and cob weight/cob); grain yield and stover yield of maize in both the seasons. Higher values of plant height (197.33 and 205.5 cm) and silking (53.67 and 54.67) was recorded with the spraying of gibberellic acid @ 60 g/ha in both the seasons, respectively. Similarly the higher yield attributes viz., no. of cobs/plant (1.48 and 1.49), cob length (17.40 and 17.78 cm), no. of grains/cob (443.33 and 456.67) and cob weight/cob (93.2 and 97.32) were recorded with the application of gibberellic acid @ 50 g/ha in both the seasons, respectively. Application of gibberellic acid @ 50 g/ha produced highest grain yield (3522 and 4277 kg/ha) and stover yield (51.05 and 5413 kg/ha) which was statistically at par with doses of 40 g/ha, 60 g/ha and tricontanol 0.1% @ 250 ml. The maximum gross return (Rs. 56,347 and 65,854), net return (37,722 and 47,229), B: C ratio (3.03 and 3.54), production efficiency (32.49 and 37.19 kg/ha/day) and economic efficiency (339.84 and 410.69 Rs./ha/day) recorded with gibberellic acid @ 50 g/ha. Enhancing of production, productivity and profitability of maize under Jhabua Hill of Madhya Pradesh gibberellic acid applied @ 50 g/ha at 4-5 leaf stage of crop.

Keywords: Foliar spray, Gibberellic acid, Yield attributes, Production efficiency

INTRODUCTION

Maize (*Zea mays* L.) in India, ranks 3rd as a food-grain crop after wheat and rice (Kumar *et al.*, 2017 and Singh *et al.*, 2017). It is considered as one of the most important world cereals crops which served as staple food more than any of the other cereal crops (Shivran *et al.*, 2013). Nowadays, phytohormones have been found to play a major role in plants development. Plant growth hormones have plentiful applications in agriculture i.e. delaying/accelerating maturity, stimulation, flowering, abscission, controlling weeds and so on (Neupane *et al.*, 2011). Gibberellins induce flowering in long-day plants which require chilling. The heading was delayed by addition of gibberellic acid (GA_3) to the root zone in super-dwarf rice (Frantz *et al.*, 2004). Gibberellins are probably one of the growth regulators that have a significant effect on flowering. Dwarfing depends upon gibberellin deficiency and dwarfing gene effects on gibberellin biosynthesis. So, by applying gibberellic acid on dwarf maize mutant, they showed normal growth after hormone treatment. In addition, long stems have more bioactive gibberellin than short stems (Naghashzadeha *et al.*, 2009). Plant growth hormones so far have been emerged as "magic chemicals" that could increase agricultural production at an unprecedented rate and help in removing and circumventing many of the barriers imposed by genetics and environment. Spraying different concentration of gibberellic acid over the plans at 3-4 leaf growth stage increased seed yield and yield components in soybean (Azizi *et al.*, 2012). Therefore, the present study was conducted to investigate the suitable doses of gibberellic acid for increasing the growth and yield attributes and yield of maize under Jhabua hills of Madhya Pradesh.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm, Zonal Agricultural Research Station, Jhabua during season *kharif* 2014 and *rabi* 2014-15. The soil of the experimental block was sandy loam in texture, slightly alkaline in reaction (pH 7.4), with low of organic carbon (0.40 %), available N (210.16 kg/ha) but medium in available P (14.3 kg/ha) and K (114.50 kg/ha). The experiment was laid out in a randomized block design with 7 treatments replicated thrice. Treatments comprised of doses of gibberellic hormone i.e. T_1=20, T_2=30, T_3=40, T_4=50 T_5=60 g/ha, Tricontanol 0.1%= 250 ml/ha) and control (no application) were tried in randomized block design. Maize var. JVM-421 was planted on 12th July and 05th November and harvested on 30th October 2014 and 27th February 2015, respectively. The crop was fertilized with the 120 kg N, 60 kg

[1]*Krishi Vigyan Kendra, Jhabua, Madhya Pradesh, India*
*Corresponding Author Email: kumawatandy@gmail.com

P_2O_5 and 40 kg K_2O/ha as the recommended dose of fertilizers. A full dose of phosphorus and potassium; and 1/3 dose of nitrogen were applied at the time of sowing and remaining 2/3 dose of nitrogen was equally top dressed at 30th and 45th day after sowing by the urea. As per plan, one foliar spray of gibberellic acid was done on 4-5 leaves stage of the crop in both the seasons. Other management practices were done as per recommended package of practices. Observations on various growth and yield parameters from five randomly tagged plants in each plot were recorded at maturity following the standard procedures. Number of days taken from sowing to silk emergence and maturity was recorded when at least 50% of the plants in the four central rows within the net plot area.

Economics was calculated on the basis of prevailing market prices of different inputs and outputs. The data collected for different parameters were statistically analysed using the F-test as per the procedure given by Gomez and Gomez (1984) for randomized block design and factorial randomized block design. The results are presented at 5% level of significance (P= 0.05) for making a comparison between treatments. Production efficiency and economic efficiency was calculated by following given formula below:

$$\text{Production efficiency (kg/day/ha)} = \frac{\text{Grain yield (kg/ha)}}{\text{Total duration taken crop (days)}}$$

$$\text{Economic efficiency (Rs./ha/day)} = \frac{\text{Net return (Rs/ha)}}{\text{Total duration taken crop (days)}}$$

RESULTS AND DISCUSSION

Effect of weather

Meteorological data depicted in Fig.1 showed marked variation in weather condition during two both season. During the period of experimentation, the maximum and minimum temperature ranged from 41.7 to 16.8°C in *kharif* and 33.7 to 7.6°C in *rabi*, respectively. Total rainfall received in *kharif* 759.6 and 28.2 mm in *rabi* which was distributed during July to October in *kharif* 2014 and November to March in *rabi* 2014-15, respectively. Due to favourable temperature, less incidence of insect-pest and diseases and adequate of irrigation water resulted in better performance of the crops during *rabi* 2014-15 than *kharif* 2014.

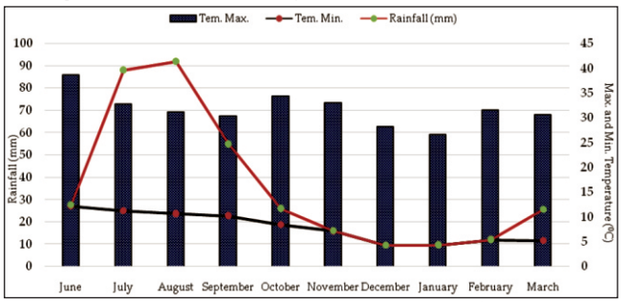

Fig. 1: Average monthly meteorological data of temperature and rainfall during the both the growing seasons

Effect on growth and yield attributes

Application of different doses of gibberellic acid leads to an increase of plant height as compared to control in both the seasons i.e. *kharif* and *rabi* (Table 1). Among different doses of gibberellic acid, application of 60 g/ha gave taller plants (197.33 and 205.5 cm) which were comparable with 50 g/ha, 40 g/ha and tricontanol 0.1%, respectively. While the smaller plant height was recorded in control plot. Further maximum days to take in silking was also recorded under gibberellic acid @ 60 g/ha (Table1). The promotion of growth either in terms of increase in plant height or the leaf area has been thought to be by increasing plasticity of cell wall followed by hydrolysis of starch to sugars which lower the water potential of the cell, resulting in entry of water into the cell causing elongation. These osmotic driven responses under influence of GA might have attributed for an increase in photo synthetic activity, accelerated translocation and efficiency of utilizing photo synthetic products, thus resulting in increased cell

Table 1: Growth and yield attributes of maize as influenced by different doses of gibberellic acid

Treatment	Plant height (cm)		Silking (No. of days)		No. of cobs /plant		Cob length (cm)		No. of grains /cob	
	Kharif 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15
T_1= Gibberellic acid @ 20 g/ha	175.93	179.83	50.67	52.00	1.21	1.30	16.50	16.56	412.00	412.55
T_2= Gibberellic acid @ 30 g/ha	178.47	184.57	51.00	52.33	1.25	1.34	16.22	16.33	409.33	412.67
T_3= Gibberellic acid @ 40 g/ha	194.40	190.83	51.67	52.67	1.42	1.39	17.20	17.31	438.33	449.57
T_4= Gibberellic acid @ 50 g/ha	194.70	202.30	53.33	54.33	1.48	1.49	17.40	17.78	443.33	456.67
T_5= Gibberellic acid @ 60 g/ha	197.33	205.50	53.67	54.67	1.40	1.39	16.98	17.25	425.27	430.33
T_6= Tricontanol 0.1% EW @ 250ml /ha	183.70	186.77	51.67	52.67	1.26	1.30	17.05	17.22	432.67	438.42
T_7= Control	164.77	172.83	50.00	51.67	1.20	1.23	16.09	16.23	406.68	409.45
CD (P= 0.05)	15.73	21.17	2.85	2.91	0.11	0.12	1.16	1.04	13.50	14.62

elongation and rapid cell division in growing portion. Gibberellic acid is a vegetative growth promoter which helps in increase of leaf length and dry weight of leaves in cilantro. Progibb (100 µl/l) was optimum for maximizing leaf production (Ramcharan, 2000). Similar results also reported by Kumar (2015) and Thavaprakaash *et al.* (2007).

Yield attributes *viz*. cobs/plant, cob length and grains/cob of maize as influenced by different doses of gibberellic acid (Table 1). Significantly, higher cobs/plant (1.48 and 1.49), cob length (17.40 and 17.78 cm) and grains/cob (443.33 and 456.67) were recorded with gibberellic acid @ 50 g/ha which was statistically at par with 40 g, 60 g/ha, and tricontanol 0.1% @ 250 ml/ha, respectively. The per cent increase in no. of cobs/plant, cob length, no. of grains/cob and cob weight/cob 23.33, 8.14 and 14.62 and 21.13, 9.55 and 12.29 and 14.94% *rabi* 2014-15 over control. Further data presented in table 2 showed that maximum cob weight of 93.82 g in kharif 2014-15 and 97.32 g in rabi 2014-15 was observed under gibberellic acid @ 50 g/ha which was statically comparable with 40 g, 60 g/ha, and tricontanol 0.1% @ 250 ml/ha. The per cent increase in cob weight under gibberellic acid @ 50g/ha by 13.58% in *kharif* and 14.94% *rabi* 2014-15 over control. Crop yield is mainly dependent on the interplay of various physiological and biochemical functions of the plant in addition to the impact of growing environment. The cause and effect relationship is difficult to understand mainly because of complexity in understanding the interplay of several processes and functions which ultimately lead to changes not only in growth, development and physiology, but also on the yield attributes that are responsible for higher yield of crop. Application of growth hormones at 4-5 leaf stage has mostly affected the strength of physiological sources so that improves growth parameters of plants (Ghodrat *et al*., 2012). The seed index did not influenced significantly due to various doses of gibberellic acid during both the seasons. These results are in conformity with the findings of Emongor (2007) in cowpea and Vasudevan *et al*. (2008) in fenugreek.

Effect on grain and stover yield

Application of different doses of gibberellic acid had a significant effect on grain and stover yield of maize (Table 2). Among different doses of gibberellic acid, highest grain yield (3607 and 4277 kg/ha) and stover yield (5105 and 5413 kg/ha) were recorded under gibberellic acid @ 50 g/ha, respectively. Increase in grain and stover yield under gibberellic acid @ 50 g/ha was 4.91, 16.44% and 11.85, 17.75% over control, respectively. Crop yield depends on the accumulation of photo-assimilates during the growing period and the way they are partitioned between desired storage organs of plant.

The plant growth regulators also increase mobilization of reserve food materials to the developing sink through increases in hydrolyzing and oxidizing enzyme activities and lead to yield increases (Jayachandran *et al*., 2000). In present study, application of gibberellic acid significantly increased the cobs/plant, cob length, no. of grains/cob and cob weight/cob and finally grain yield, these are the most important yield determining components of maize. Similar findings were also made by Ghodrat *et al.* (2012).

Table 2: Yields attributes and yields of maize as influenced by different doses of gibberellic acid

Treatment	Cob weight (g) /cob		Seed index(g)		Grain yield (kg/ha)		Stover yield (kg/ha)	
	Kharif 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15
T_1= Gibberellic acid @ 20 g/ha	85.05	87.00	23.83	23.93	3458	3730	4608	4769
T_2= Gibberellic acid @ 30 g/ha	86.00	88.81	23.87	23.97	3472	3805	4638	4822
T_3= Gibberellic acid @ 40 g/ha	92.36	94.67	24.33	24.70	3567	4208	4969	5346
T_4= Gibberellic acid @ 50 g/ha	93.82	97.32	24.57	24.87	3607	4277	5105	5413
T_5= Gibberellic acid @ 60 g/ha	90.00	90.83	23.80	24.30	3522	3968	5014	5222
T_6= Tricontanol 0.1% EW @ 250 ml /ha	92.03	93.00	23.90	24.30	3548	4053	4906	5228
T_7= Control	82.60	84.67	23.57	23.83	3438	3673	4564	4597
CD (P= 0.05)	5.96	4.58	NS	NS	148	155	307	301

Effect on economics

Gross, net returns and B:C ratio of the maize significantly influence by various doses of gibberellic acid during both the seasons (Table 3). Application of gibberellic acid @ 50 g/ha fetched the maximum gross return (Rs. 56,347 and 65,854/ha), net return (Rs. 37,722 and 47,229/ha) and B: C ratio (3.03 and 3.54) in both the respective seasons. While the lowest values of these economics parameters were in control plot. This might be due to the higher yields and net returns associated with the respective treatments (Kumar *et al.*, 2015). Similar results were also reported by Shinde and Nawalgatti (2010).

Table 3: Economics of maize as influenced by different doses of gibberellic acid

Treatment	Gross returns (Rs./ha)		Net returns (Rs./ha)		B:C ratio	
	Kharif 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15	*Kharif* 2014	*Rabi* 2014-15
T 1= Gibberellic acid @ 20 g/ha	53600	57508	35050	38958	2.89	3.10
T 2= Gibberellic acid @ 30 g/ha	53824	58601	35249	40026	2.90	3.15
T 3= Gibberellic acid @ 40 g/ha	55603	64832	37003	46232	2.99	3.49
T 4= Gibberellic acid @ 50 g/ha	56347	65854	37722	47229	3.0 3	3.54
T 5= Gibberellic acid @ 60 g/ha	55064	61405	36414	42755	2.95	3.29
T 6= Tricontanol 0.1% EW @ 250 ml /ha	55262	62562	36662	43962	2.97	3.36
T 7= Control	53264	56485	34764	37985	2.88	3.05
CD (P= 0.05)	2013	2036	2013	2036	0.11	0.12

Effect on production and economic efficiency

Production and economic efficiency were influenced by the different doses of gibberellic acid in both the seasons (Fig 2 & 3). The highest production efficiency (32.49 and 37.19 kg/ha/day) and economic efficiency (339.84 and 410.69 Rs./ha/day) were observed with the application of gibberellic acid @ 50 g/ha, respectively. Increase in production and economics efficiency under gibberellic acid @ 50 g/ha was 4.26, 14.68% and 7.62, 21.23% over control, respectively. This could be due to this treatments was produced higher grain yield and net returns. Similar findings were also made by Shinde and Nawalgatti (2010).

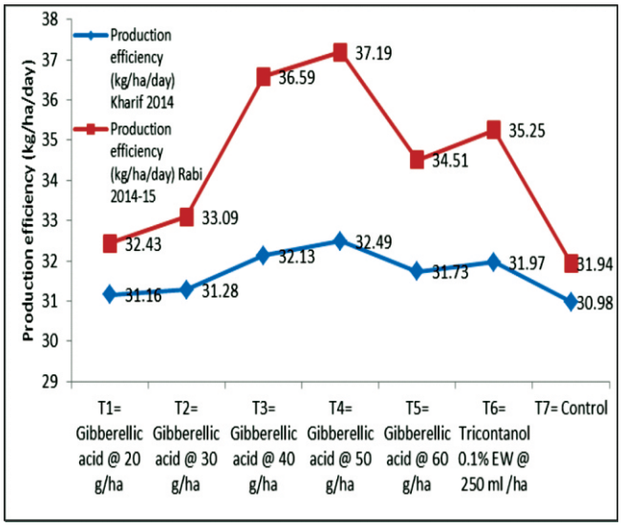

Fig.2: Production efficiency of maize as influenced by different doses of gibberellic acid

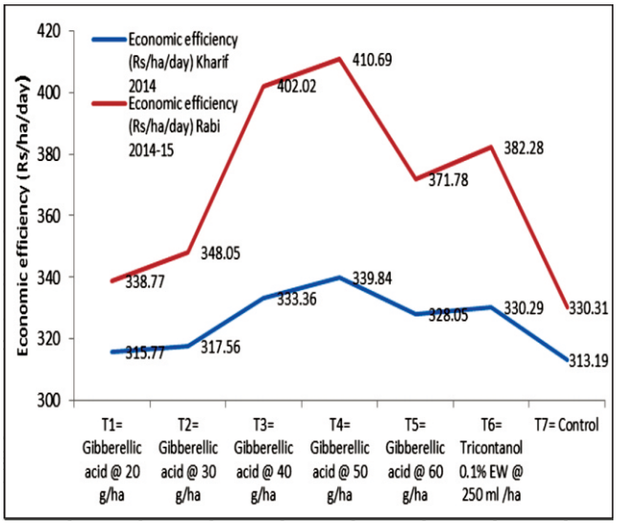

Fig.3: Economics efficiency of maize as influenced by different doses of gibberellic acid

CONCLUSION

From the above findings, it may be concluded that one foliar spray of gibberellic acid (Progibb 40%) @ 50 g/ha at 4-5 leaf stage produced higher grain yield, stover yield and economics of the maize under Jhabua Hill of Madhya Pradesh.

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