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Pre-sowing seed treatments on growth, yield and yield attributing traits of maize (*Zea mays* L.) cv. Drona (KMH-2589)

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Abstract
An investigation on "Pre-sowing seed treatments on growth, yield and yield attributing traits of Maize (*Zea mays* L.) cv. Drona (KMH-2589)" was carried out in post graduate laboratory of Seed Science at Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). The field experiment was laid out in Randomized Block Design with three replications. Simultaneously, laboratory experiment was laid out in Completely Randomized Design with four replications using 13 pre-sowing treatments with following Plant Growth Regulators with different concentrations IAA, IBA, GA3 (50,100,200 PPM) Cytokines (10, 20, 40 PPM) including Control for duration of 12 hours. Under the study among the various treatments used for pre-sowing the analysis of variance for the field as well as laboratory data revealed that mean sum of squares due to pre-sowing treatments were highly significant in $GA_3$200ppm than control. This treatment gave maximum plant height (192.67 cm) with higher seed yield per plant (88.63g) and with good seedling characters and this treatment came up with greatest benefit cost ratio (3.76:1). Hence $GA_3$200ppm can be recommended as a pre-sowing seed treatment of maize seed for improving the quality and yield of maize.

Keywords: Maize, plant growth regulators, GA3, benefit cost ratio

Introduction

Maize (*Zea mays* L.) is third most important cereal crop next to wheat and rice in the world. It is one of the economically important cereal crop grown almost in all the continents of tropics, sub-tropics and temperate regions. It is a member of grass family Graminaceae (2n=20). This cereal is referred to as "Miracle Crop" and "Queen of the Cereals" due to high productivity (Ikramullah *et al.,* 2011). Highly versatile crop having wider adaptability & has highest genetic yield potential among cereals. It has world-wide significance as human food, animal feed and as a raw material for large number of industrial products. It is used as a basic raw material for the production of starch, oil, protein, alcoholic beverages and food sweetener and more recently as bio fuel. Maize is also used for the production of ethanol, animal feed and other maize products, such as corn starch and corn syrup.

In India, maize is grown in an area of 9.86m ha with an average productivity of 2664kg/ha and production of 26.26million tones. Whereas in Uttar Pradesh, it occupies an area 0.83 million hectares with an average productivity of 1889kg/ha and production of 1.56 million tonnes (Source: Agriculture statistics at glance, 2017).

Seed invigoration techniques are used to enhance germination and vigour of seed and seedling growth. It includes the pre-soaking of seeds that improves seed performance by rapid and uniform germination, normal and vigorous seedlings, which result in faster and higher rate of germination and emergence in different crops (Farooq *et al.,* 2007), which also helps seedlings to grow in biotic or abiotic stress condition (Ashraf and Fooland, 2005; Khan *et al*., 2009a and 2009b).

Materials and Methods

The maize seeds were treated with growth regulators in different concentrations for duration of 12 hours. Seeds was subjected to growth regulators (IAA, IBA and GA_3), each with 50, 100 and 200 ppm while Cytokinin (10, 20 and 40ppm). There were 13 pre-sowing treatments including control on maize (*Zea mays* (L.) genotype Drona (KMH-2589).

Thus treatments were T0 (Control), T1 (IAA 50ppm), T2 (IAA 100ppm), T3 (IAA 200ppm), T4 (IBA 50ppm), T5 (IBA 100ppm), T6 (IBA 200ppm), T7 (GA3 50 ppm),T8 (GA3 100 ppm), T9 (GA3 200 ppm), T10 (Cytokinin 10 ppm), T11 (Cytokinin 20 ppm) and T12 (Cytokinin 40 ppm). The field experiment was laid out in Randomized Block Design with three replications.100 seeds of each treatment were sown during kharif 2019 in well prepared plots of 3.6 m^2 with seed to seed distance of 20 cm and row to row distance of 60 cm. These thirteen treatments were evaluated for 8 characters. Simultaneously, laboratory experimented was conducted with the same set of above 13 treatments. Laboratory experiment was laid out in Completely Randomized Design with four replications. In laboratory experiment data were recorded for 7 characters. The analysis of laboratory data was done as per of Complete Randomized Design (C.R.D) while the analysis of field data was done according to the procedure of randomized block design for each character as per methodology suggested by Fisher (1936).

Results and Discussion

Analysis of variance for the Field experiment: Analysis of variance for the field data (Table-1) revealed that mean sum of squares due to seed priming treatments were highly significant at 1% level of significance for all the characters under study indicating presence of good amount of variability among the treatments for all the characters used in study. This indicated ample scope for seed priming in maize

Mean performances of various treatments under field experiment along with statistics is given in Table-1. In the present study, yield attributes such as days to 50% tasseling, days to 50% silking and days to maturity were reduced as compared to the control which indicated faster growth and development from the treated seeds. However, different treatments have different responses. On the other hand other growth parameters such as plant height and yield parameters, cob length, girth and no. of kernels rows and total no. of kernels per cob were significantly increased in treated seeds. This may be due to the rapid physiological growth and developmental activities in the treated seeds as compared to the untreated seeds.

In the present study of field experiment, seed priming with GA3 200ppm was found significantly higher as compared to other treatment as well as control. It significantly affected all the characters under field study. Pre-sowing with the application of GA3 200ppm this treatment gave maximum plant height (192.67 cm) with higher seed yield per plant (88.63g) in maize. This treatment was found superior not only for seed yield per plant but also suitable in terms of earliness in maize.

Yield is the end product of any crop and is a function of multiple factors which affect crop from sowing to harvest. Seed invigoration with growth regulators significantly increased yield attributes in maize. Since high and smooth germination is the basic step in the later crop growth and development. Seed priming with priming agents had generally encouraged smooth germination over the untreated seeds due to which more yield was obtained from plants raised from treated seeds. Present results are in accordance with Bhakt *et al.,* (2010) who also reported that priming agents affected yields. This is because higher germination coupled with high root and shoot length makes the plant capable of taking the advantage of available moisture or rainfall. This results in early and fast developmental growth which in turn helps to plant to reproduce early. All this affect the final yield of the plant which is higher as compared to unprimed seeds. In the present study, yield attributes such as days to 50% tasseling, days to 50% silkingand days to maturity were reduced as compared to the control which indicated faster growth and development from the treated seeds. However, different treatments have different responses. On the other hand other growth parameters such as plant height and yield parameters, cob length, girth and no. of kernels rows and total no. of kernels per cob were significantly increased in treated seeds. This may be due to the rapid physiological growth and developmental activities in the treated seeds as compared to the untreated seeds. Kropi *et al.,* (2018) [8] reported that growth regulators showed significant response on morphological, physiological and yield attributing characters of brinjal. The result revealed that a morphological character with respect to plant height was significantly improved by GA3 treatment at 100 ppm. Rathod *et al.,* (2015) reported that application ofGA3 100 ppm produced maximum number of green pods, yield per plant and yield per hectare. Moniruzzaman *et al.,* (2014) [9] reported fromexperiment on brinjal (*Solanum melongena* L.) that application of The GA3 (Gibberellic acid) had significant effect on plant height and stem diameter. Netam *et al.,* (2014) [10] reported from brinjal experiment that the highest number of branches, number of fruits, fresh fruit weight was observed and total soluble solid, nitrate reductase activity was recorded by the treatment combination of GA3 @ 10 ppm, and NAA @ 20 ppm

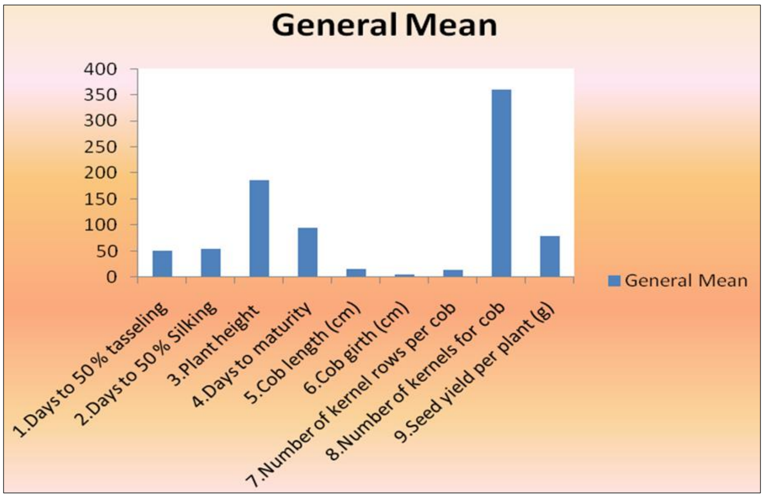

Fig 1: Mean performance of different seed treatments for field characters in Maize (*Zea mays* L.)

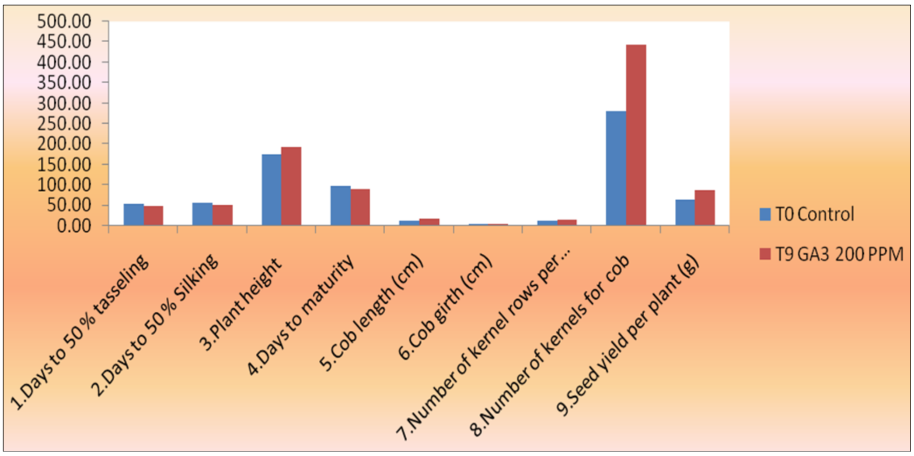

Fig 2: Effect of control and priming treatment T9 (GA3 200ppm) on field characters in Maize

Table 1: Mean performance of different seed treatments in field experiment in Maize (*Zea mays* L.) cv. Drona (KMH-2589) during Kharif, 2019

Treatments symbols	Days to 50% tasseling	Days to 50% Silking	Plant height	Days to maturity	Cob length (cm)	Cob girth (cm)	Number of kernel rows per cob	Number of kernels for cob	Seed yield per plant (g)
T_0	54.00	57.00	175.67	97.00	13.67	4.13	12.67	281.33	64.89
T_1	52.00	55.00	185.00	95.00	14.67	4.63	14.00	391.33	73.19
T_2	50.67	53.67	186.00	93.67	15.33	4.70	14.67	404.67	76.28
T_3	50.67	53.67	189.67	93.67	15.67	4.80	14.67	401.33	79.37
T_4	53.33	56.33	179.00	96.33	14.33	4.33	12.67	311.33	71.16
T_5	53.67	56.67	179.67	96.67	15.33	4.47	13.33	318.00	71.88
T_6	53.67	56.67	183.67	96.67	15.33	4.60	13.33	364.00	75.32
T_7	50.67	53.67	190.33	93.67	17.33	4.73	15.67	420.33	85.09
T_8	50.33	53.33	192.00	93.33	18.00	4.77	16.00	442.33	85.87
T_9	48.33	51.33	192.67	91.33	18.33	4.77	16.67	444.00	88.63
T_{10}	50.67	53.67	184.33	93.67	15.00	4.53	15.00	283.00	83.69
T_{11}	50.67	53.67	186.00	93.67	15.33	4.53	15.67	292.67	85.17
T_{12}	48.33	51.33	186.33	91.33	16.33	4.67	16.00	311.33	86.43
S.Em	0.54	0.54	1.09	0.54	0.39	0.06	0.59	12.71	2.29
CD (5%)	1.58	1.58	3.18	1.58	1.14	0.18	1.72	37.1	6.68
CV	1.82	1.72	1.02	0.99	4.31	2.18	7.01	6.13	5.02
GM	51.31	54.31	185.41	94.31	15.74	4.59	14.64	358.9	79

Table 2: Analysis of Benefit cost Ratio

Sl. No.	Treatments	Seed yield per plot(kg)	Market price of the produce	Additional benefits	Cost: Benefit ratio
T_0	Control	5.85	87.75	0	
T_1	IAA 50ppm	6.6	99	11.25	1.61:1
T_2	IAA 100ppm	6.87	103.05	15.3	2.19:1
T_3	IAA 200ppm	7.14	107.1	19.35	2.76:1
T_4	IBA 50ppm	6.39	95.85	8.1	1.62:1
T_5	IBA 100ppm	6.48	97.2	9.45	1.89:1
T_6	IBA 2000ppm	6.78	101.7	13.95	2.79:1
T_7	GA3 50 PPM	7.65	114.75	27	3.18:1
T_8	GA3 100 PPM	7.74	116.1	28.35	3.34:1
T_9	GA3 200 PPM	7.98	119.7	31.95	3.76:1
T_{10}	Cytokinin 10 ppm	7.53	112.95	25.2	2.52:1
T_{11}	Cytokinin 20 ppm	7.68	115.2	27.45	2.75:1
T_{12}	Cytokinin 40 ppm	7.77	116.55	28.8	2.88:1

The treatment based on GA3 @ 200 ppm has been found to be the most effective dose by giving highest net return mainly due to the production of larger and uniform sized seeds with better quality, which attracted the consumer and provided good market price. The application of GA3 @ 200ppm (T9) came up with the greatest benefit: cost ratio (3.76: 1), which was followed by 3.34:1 due to GA3 @ 100 ppm (T8) treatment. TanushreeSaha *et al.*, (2019) reported that estimated benefit: cost ratio (B:C) was highest (2.92:1) for GA3 @ 40 ppm, followed by GA3 @ 20ppm (2.63:1). From this study, foliar spray of GA3 @ 40 ppm at 15 and 30 days after planting was recommended as cost-effective treatment for improvement of plant growth, productivity and fruit quality of strawberry grown in the Gangetic alluvial region of West Bengal.

Mean performances of various treatments under Laboratory experiment along with statistics is given in Table-3: The mean performance of seed germination % ranged from 68.25 to 87.5 with a grand mean of 78.00. For seed germination %, treatments T9 (GA3 200 PPM) (87.5) was significantly higher in germ inability in comparison to control. It was statistically at par with T8 (GA3 100 PPM) (84.25), T7 (GA3 50 PPM) (84), T3 (IAA 200ppm) (83), T2

(IAA 100ppm) (82.25), T1 (IAA 50ppm) (79.75). Germination and seedling establishment are critical stages which affect both quality and quantity of crop yields. Soil water content is the key factor affecting seed germination and plant establishment in the arid and semiarid areas. The present study revealed that, compared with control group, germination % increased dramatically after seed treatments. The seeds treated with GA3 200 PPM had maximum root length and shoot length. Minimum root and shoot length was recorded under control. An increase in root length might be the result of higher embryo cell wall extensibility. Increased root length by GA3 indicates that GA3 stimulated hydrolytic enzymes that are needed for degradation of the cells surrounding the radical. These results are in accordance with the work of Jett *et al*., (1996) who reported that root growth rates of matric primed seeds were significantly higher than non primed seedlings at most temperatures. Rapid growth of hybrids is associated with increased content of endogenous GA3, which promote seedling vigour, increase shot height and weight and enhance grain yield as reported by Rood *et al*., (1990).

Table 3: Mean performance of different seed invigoration treatments under lab conditions in Maize (*Zea mays* L.) cv. Drona (KMH-2589) during Kharif, 2019

Treatments No.	Treatments	Seed Germination %	Root length (cm)	Shoot length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)	Seedling vigour index 1	Seedling vigour index 2
T0	Control	68.25	16.03	9.7	8.25	1.42	1755	96.8
T1	IAA 50ppm	79.75	18.88	11.35	8.9	1.7	2412.2	135.72
T2	IAA 100ppm	82.25	18.52	12.48	9.08	1.72	2549.22	141.38
T3	IAA 200ppm	83.01	19.25	12.93	9.78	1.75	2674.11	145.24
T4	IBA 50ppm	70.5	17.4	11.62	8.55	1.75	2045.28	123.28
T5	IBA 100ppm	75.75	16.1	12.05	8.68	1.81	2142.5	136.87
T6	IBA 200ppm	77.01	17.89	11.92	9.78	1.87	2294.9	143.89
T7	GA3 50 PPM	83.9	18.85	12.79	9.21	2.14	2657.35	180.01
T8	GA3 100 PPM	84.25	20.37	13.36	9.63	2.15	2838.69	181.25
T9	GA3 200 PPM	87.5	21.2	13.36	9.8	2.38	3026.42	207.83
T10	Cytokinin 10 ppm	69.25	17.98	11.35	8.82	1.7	2030.87	117.15
T11	Cytokinin 20 ppm	74.75	18.29	11.35	8.5	1.83	2217.09	136.58
T12	Cytokinin 40 ppm	77.75	17.73	11.48	9.02	1.96	2269.48	152.09
	S.Em	2.72	0.57	0.41	0.22	0.05	105.79	6.45
	CD (5%)	7.77	1.64	1.17	0.65	0.14	302.61	18.47
	CV	6.97	6.22	6.88	4.93	5.38	8.9	8.84
	GM	78.00	18.34	11.98	9.07	1.86	2377.93	146

T0 (Control), T1 (IAA 50ppm), T2 (IAA 100ppm), T3 (IAA 200ppm), T4 (IBA 50ppm), T5 (IBA 100ppm), T6 (IBA 200ppm), T7 (GA3 50 PPM), T8 (GA3 100 PPM), T9 (GA3 200 PPM), T10 (Cytokinin 10 ppm), T11 (Cytokinin 20 ppm), andT12 (Cytokinin 40 ppm

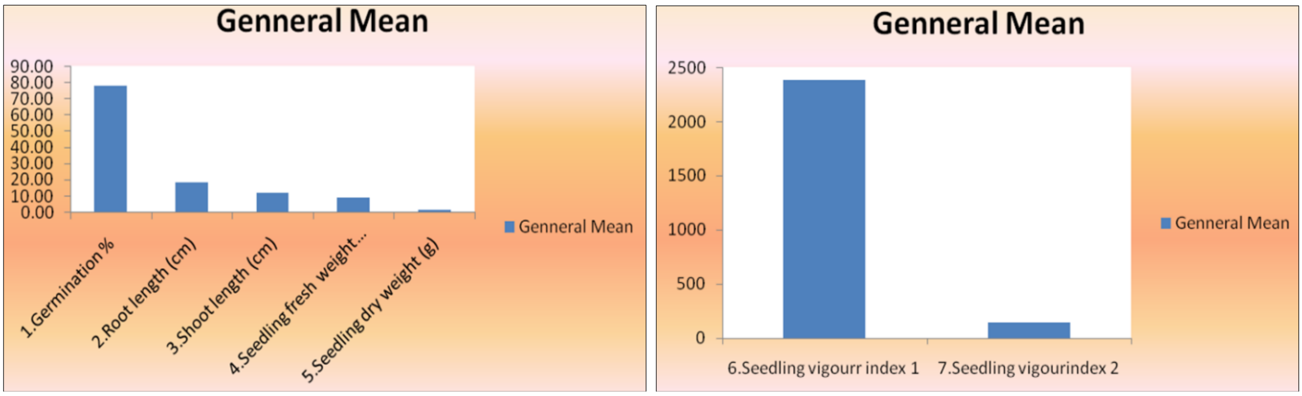

Fig 3: Mean performance of different seed treatments for lab characters in Maize (*Zea mays* L.*)*

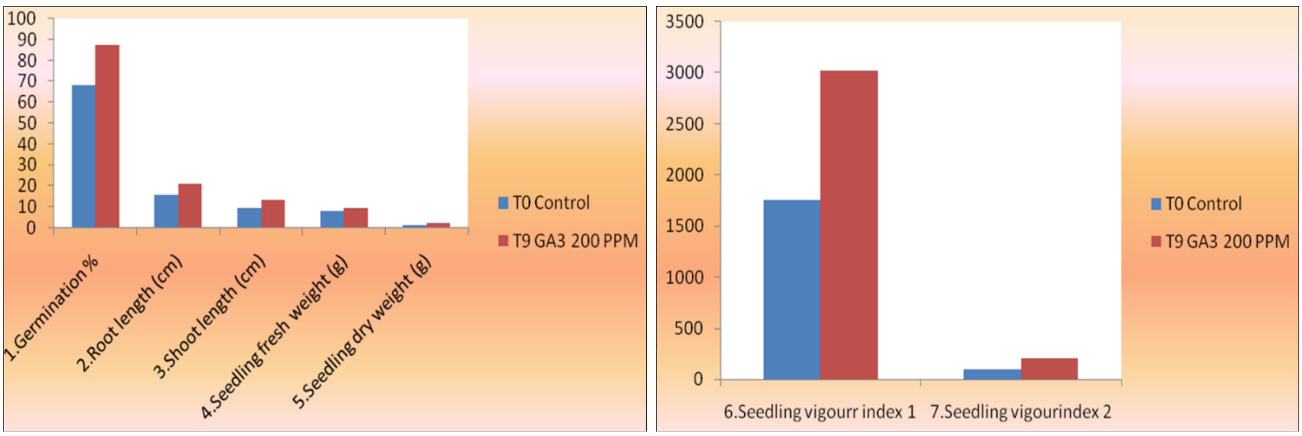

Fig 4: Effect of control and priming treatment T9 (GA3 200ppm) on lab characters in Maize

Thus, under laboratory and field experiment GA_3 50ppm was found superior over other treatments. Application of GA_3 50ppm not only affected the physiological characters under laboratory conditions but also the yield attributed under field experimentation. Improvement in the seed yield with the application of growth regulators in different concentrations was also reported in the past. Afzal *et al*., (2008) [3] from experiment on spring maize (*Zea mays L*.) where maize seeds were subjected to hormonal priming with GA3 or IAA solutions. Pre-sowing seeds treatments resulted in a higher germination percentage and germination index, lower mean germination time and mean emergence time. All seed treatments resulted in higher seedling fresh and dry weight compared with that of control with maximum dry weight recorded for seeds subjected GA3

In conclusion, on the basis of the results obtained in the present investigation, the interference can be drawn that different concentrations of plant growth regulators had considerable pre-sowing seed treatment on growth, yield and yield attributing traits of maize. Among them, application of GA3@200ppm had beneficial effects for improving growth, yield and seedling characters of maize cv. Drona (KMH-2589) with maximum B: C ratio. Hence, GA3 @200 ppm can be recommended for farmers for better plant growth, yield, quality and returns of Maize cv. Drona (KMH-2589).

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