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# INFLUENCE OF PLANT GROWTH REGULATORS ON SEED YIELD, QUALITY AND STORABILITY OF SINGLE CROSS MAIZE HYBRID GH-0727

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**ABSTRACT**
A field experiment was conducted during *kharif*2015 at the Main Agricultural Research Station (Saidapur Unit), UAS, Dharwad to study the influence of plant growth regulators on field performance and yield in maize hybrid GH-0727.Among the plant growth regulator treatments, $GA_3$ (50 ppm) + IBA (100 ppm) recorded significantly higher plant height at harvest (203.33 cm), SPAD value (56.24) with minimum number of days to 50 percent tasseling and silking (53 and 57.33 days, respectively). The treatment, $GA_3$ (50 ppm) + IBA (100 ppm) also resulted in higher cob length (16.60 cm), cob girth (13.46 cm), number of rows per cob (17.33), number of seeds per row (29.33),yield per plant (72.37g), test weight (28.03 g), yield per ha (24.87 q/ha)and shelling per cent (83.66), which was on par with $GA_3$ (75 ppm) + IBA (125 ppm).During storage, higher germination per cent (98.05 and 97.25) and field emergence( 90.60 and 89.70 ) were recorded at first and second months of storage period and significantly higher seedling vigour index (3092, 2874 and 2493) was recorded at first, second and third month of storage period with the treatment which received $GA_3$(50 ppm) + IBA (100 ppm).

## INTRODUCTION

In the world agricultural economy, maize (*Zea mays* L.) is one of the important cereal crops as it has higher yield potential than any other crop hybrids and hence referred to as the "queen of cereals". Maize is considered as a promising option for diversifying agriculture in upland areas of India. Now it ranks as the third most important food grain crop in India. When commercial hybrid maize was first introduced, few people realized its potential to increase the world's agricultural productivity. Dr.NormanE.Borlaug was of the opinion that maize has the highest yield potential among the cereals. In the last two decades, there was a revolution in rice and wheat and the next few decades will be known as maize era. By 2020 AD the requirement of maize in various sectors will be around 100 million tonnes (Anon., 2015). The most common types of hybrids in maize are single-cross, three-way and double-cross hybrids.

Single cross maize hybrids are highly productive than other type hybrids. They are more uniform than other type of hybrids because of their genetic architecture *i.e.*, they are heterozygous and homogenous in nature. Single cross hybrid seed production is expensive than other type of maize hybrids, it is due to lower seed yield of $F_1$ as the seed parent is inbred in case of single cross hybrid seed production. So, there is a need to increase $F_1$seed yield from female inbred line through various means, in single cross maize hybrid seed production. In this regard, use of growth regulators can play an important role in altering the source sink relationship (Taiz and Zeiger, 2002) thus increasing the growth and seed yield of many field crops (Das and Das, 1996). An exogenous application of plant growth regulator affects the endogenous hormonal pattern of the plant, either by supplementation of sub-optimal levels or by interaction with their synthesis, translocation or inactivation of existing hormone levels (Arshad and Frankenberger, 1993). Hence, in the present study, an attempt has been made to know the "influence of plant growth regulators on field performance and yield of maize hybrid GH-0727".

## MATERIALS AND METHODS

The field experiment was carried out at the Main Agricultural Research Station (Saidapur unit) UAS, Dharwad during kharif 2015 to evaluate the influence of plant growth regulators on field performance and yield of maize hybrid GH-0727. The experiment was laid out in randomized complete block design with nine treatments viz., $T_1$: Control, $T_2$: $GA_3$ (50 ppm), $T_3$: IBA (100 ppm), $T_4$: $GA_3$ (50 ppm) + IBA (100 ppm), $T_5$: $GA_3$ (75 ppm) + IBA (125 ppm), $T_6$: mepiquat chloride (200 ppm), $T_7$: mepiquat chloride (300 ppm), $T_8$: salicylic acid (1mM) and $T_9$: salicylic acid (1.5mM) and replicated thrice. The parental seeds of maize hybrid GH-0727 were collected from the National Seed Project (NSP), UAS, Dharwad. The sowing was taken up in 2:1 row proportion i.e. two female rows followed by one male row for each of the treatment. $GA_3$, IBA and $GA_3$ + IBA were sprayed at 4 to 6 leaf stage and flowering stage whereas, Mepiquat chloride and salicylic acid were sprayed at 30 days after sowing and all the treatments were imposed only on female parent. Five tagged plants from each net plot were used to record the observations. Observations on growth parameters like plant height at harvest (cm), SPAD value, flowering parameters like days to 50 per cent flowering and yield parameters like cob length (cm), cob girth (cm), number of rows per cob, number of seeds per row, seed yield per plant (g) and seed yield per ha (q) were recorded. The data was subjected to the statistical analysis (Panse and Sukhatme, 1967). Harvested seeds were stored in HDPE bags for six months, and the observations on germination percent, field emergence and seedling vigour index were recorded at 0, 1, 3 and 6 months after storage using standard tests as prescribed by ISTA rules (Anon., 2011). Seedling vigour index was calculated by using formula given by AbdulBaki and Anderson (1973).

Seedling vigour index = Mean germination (%) x [Root length (cm) + Shoot length (cm)]

The data collected from the experiment was analyzed statistically by adopting the procedures as described by Sundarajan *et al.* (1972).

## RESULTS AND DISCUSSION

Significant differences were observed among the treatments with regard to growth, flowering and yield parameters. Among the growth regulator treatments, $GA_3$ (50 ppm) + IBA (100 ppm) recorded higher plant height at harvest (203.33cm) and SPAD value at 60 DAS (56.24), which were on par with $GA_3$ (75 ppm) + IBA (125 ppm) (201.33cm and 56.08, respectively), whereas the lowest plant height(176 cm) and SPAD values (30.24) were recorded in control (Table 1). Higher plant height in case of $GA_3$ and IBA treatment was due to apical dominance effect of auxins resulting increase in growth rate of cells, enhanced cell division and cell elongation and translocation of $GA_3$ to the aerial part of plants (MemenSurahman *et al.*, 2015). This perhaps occurs to an extent that is enough to increase epicotyl size and the consequent increase in first node height which is sufficient to positively affect plant height. Similar beneficial effect of auxins and gibberellins on plant height was reported by Tiwari *et al.* (2011), Rahman *et al.* (2012) and MemenSurahman *et al.* (2015) in rice. Higher SPAD value was due to increase in strength of physiological source by increasing effective age of the leaves thereby enhancing photosynthetic capacity of the source. Similar findings were reported by VahidGhodrat *et al.* (2012) in Maize.

A progressive decrease in number of days to 50 per cent flowering was noticed with application of growth regulators (Table 1). Both the treatments viz., $GA_3$ (50 ppm) + IBA (100 ppm) and $GA_3$ (75 ppm) + IBA (125 ppm) lead to less number of days for both 50 per cent tasseling and silking(53days and 57.33 days) compared to that of control (56.33 days and 61.33 days). This early flowering might be due to the effect of $GA_3$ and auxins, which seem to decrease ABA concentration and boots t-ZR (trans-ZeatinRiboside) up in leaf that might be related to flower buds initiation and early flowering VahidGhodrat *et al.*, 2012.The early flowering could be correlated with early

**Table 1: Influence of growth regulators on plant height, days to 50% tasseling and silking, SPAD values, yield and yield components in maize hybrid GH-0727**

| Treatments | Plant height at harvest (cm) | SPAD values 60 DAS | Days to 50% Tasseling | Days to 50% Silking | Cob length (cm) | Cob girth (cm) | No. of rows/ Cob | No. of seeds/ row | Seed yield per plant (g) | Seed yield (q/ha) | Test weight (g) | Shelling per cent (%) | Per cent seed set (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_{1:}$ Control - Water Spray | 176.00 | 30.24 | 56.33 | 61.33 | 12.63 | 10.13 | 12.00 | 19.00 | 65.72 | 22.59 | 22.53 | 77.33(61.57) | 67.96(55.56) |
| $T_{2:}$ $GA_3$ @ 50 ppm | 193.00 | 50.87 | 53.66 | 58.33 | 13.40 | 10.86 | 12.66 | 22.66 | 68.28 | 23.43 | 24.60 | 79.66(63.19)* | 68.16(55.68)* |
| $T_{3:}$ IBA @ 100 ppm | 194.00 | 50.25 | 54.00 | 58.33 | 14.13 | 11.26 | 13.33 | 25.33 | 68.54 | 23.60 | 26.03 | 79.33(62.96) | 70.26(57.00) |
| $T_{4:}$ $GA_3$ @ 50 ppm + IBA @ 100 ppm | 203.33 | 56.24 | 53.00 | 57.33 | 16.60 | 13.46 | 17.33 | 29.33 | 72.37 | 24.87 | 28.03 | 83.66(66.16) | 74.76(59.87) |
| $T_{5:}$ $GA_3$ @ 75 ppm + IBA @ 125 ppm | 201.33 | 56.08 | 53.00 | 57.33 | 16.23 | 13.23 | 16.00 | 28.00 | 71.16 | 24.44 | 27.50 | 83.30(65.90) | 74.06(59.40) |
| $T_{6:}$ Mapiquat chloride @ 200 ppm | 183.00 | 50.97 | 54.33 | 58.66 | 12.83 | 11.00 | 12.66 | 22.00 | 68.06 | 23.38 | 24.16 | 80.00(63.45) | 65.80(54.24) |
| $T_{7:}$ Mapiquat chloride @ 300 ppm | 180.33 | 49.47 | 54.66 | 58.66 | 12.70 | 10.16 | 12.00 | 21.66 | 67.03 | 23.01 | 23.60 | 79.66(63.20) | 65.50(54.05) |
| $T_{8:}$ Salicylic acid @ 1mM | 199.00 | 53.58 | 53.66 | 57.66 | 15.96 | 13.13 | 16.00 | 27.84 | 70.08 | 24.07 | 27.86 | 81.66(64.67) | 73.86(59.29) |
| $T_{9:}$ Salicylic acid @ 1.5 mM | 198.00 | 52.23 | 53.33 | 57.66 | 15.86 | 13.10 | 15.33 | 27.66 | 69.44 | 23.86 | 27.06 | 81.33(64.40) | 73.13(58.82) |
| Mean | 192.00 | 49.99 | 54.00 | 58.37 | 14.48 | 11.81 | 14.14 | 24.83 | 68.96 | 23.69 | 25.71 | 80.66(63.95) | 70.39(57.10) |
| S.Em± | 5.01 | 1.54 | 0.34 | 0.30 | 0.62 | 0.53 | 0.66 | 1.19 | 1.55 | 1.52 | 0.55 | 0.56 | 1.51 |
| CD (0.05) | 15.02 | 4.61 | 1.04 | 0.92 | 1.87 | 1.61 | 1.98 | 3.59 | 4.65 | 4.56 | 1.66 | 1.69 | NS |

* Values in the parenthesis indicate arcsine transformed values

**Table 2: Influence of growth regulators on seed quality during storage of maize hybrid GH-0727**

| Treatments | Germination (%) Storage months | | | | Field emergence (%) Storage months | | | | Seedling vigour index Storage months | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | 1 | 2 | 6 | Initial | 1 | 2 | 6 | Initial | 1 | 2 | 3 | 6 |
| $T_{1\text{-(Cloth Bag)}}$ | 94.33(76.22)* | 93.51(75.24) | 92.36(73.95) | 88.42(70.11) | 84.33(66.75) | 84.24(66.61) | 83.36(66.16) | 79.26(62.91) | 2520 | 2369 | 2190 | 2165 | 1774 |
| $T_2$ HDPE bag (700-800 gauges) | 94.33(76.22) | 93.72(75.49) | 92.45(74.05) | 90.60(72.15) | 84.33(66.75)* | 84.30(66.60) | 83.53(66.66) | 78.10(62.10) | 2520 | 2392 | 2231 | 2190 | 1890 |
| $T_3$ HDPE bag + $GA_3$ @ 50 ppm | 95.66(77.98) | 95.41(77.63) | 95.11(77.22) | 91.96(73.05) | 90.33(72.20) | 90.02(71.58) | 89.12(70.74) | 84.58(66.88) | 2856 | 2660 | 2585 | 2376 | 2028 |
| $T_4$ HDPE bag + IBA @ 100 ppm | 95.30(77.48) | 94.95(77.01) | 94.65(76.63) | 91.50(73.63) | 88.66(70.47) | 88.32(70.02) | 87.42(69.23) | 82.90(65.57) | 2808 | 2572 | 2395 | 2242 | 1978 |
| $T_5$ HDPE bag + $GA_3$ @ 50 ppm + IBA @ 100 ppm | 98.30(82.51) | 98.05(81.97) | 97.52(80.94) | 92.10(73.68) | 92.00(73.76) | 90.60(72.15) | 89.70(71.28) | 84.24(66.61) | 3478 | 3092 | 2874 | 2493 | 2112 |
| $T_6$ DPE bag + $GA_3$ @ 75 ppm + IBA @ 125 ppm | 97.66(81.20) | 97.41(80.74) | 96.38(79.03) | 92.06(73.53) | 91.33(73.04) | 90.41(71.96) | 89.51(71.10) | 83.90(66.34) | 3345 | 2914 | 2685 | 2441 | 2049 |
| $T_7$ HDPE bag + Mapiquat chloride @ 200 pp | 95.00(77.08) | 94.65(76.63) | 94.30(76.19) | 91.04(72.58) | 86.66(68.73) | 86.40(68.36) | 85.50(67.62) | 81.12(64.25) | 2584 | 2422 | 2322 | 2219 | 1865 |
| $T_8$ HDPE bag + Mapiquat chloride @ 300 ppm | 94.67(76.65) | 94.27(76.15) | 94.27(76.15) | 90.76(72.30) | 85.33(67.62) | 85.03(67.24) | 84.13(66.52) | 79.82(63.31) | 2536 | 2381 | 2312 | 2208 | 1845 |
| $T_9$ HDPE bag + Salicylic acid @ 1mM | 96.66(77.82) | 95.15(77.28) | 94.88(76.92) | 91.10(72.64) | 91.00(73.31) | 89.40(71.00) | 88.50(70.18) | 83.02(65.67) | 2913 | 2605 | 2493 | 2328 | 1993 |
| $T_{10}$ HDPE bag + Salicylic acid @ 1mM | 96.33(77.56) | 94.88(76.92) | 94.24(76.16) | 90.80(72.34) | 89.66(72.33) | 89.16(70.78) | 88.26(69.96) | 82.94(65.60) | 2840 | 2582 | 2421 | 2300 | 1904 |
| Mean | 95.82(77.89) | 95.20(77.34) | 94.61(76.52) | 91.03(72.60) | 88.36(68.33) | 87.78(68.81) | 86.93(68.09) | 81.98(64.88) | 2840 | 2598 | 2451 | 2296 | 1944 |
| S. Em± | 0.83 | 0.80 | 0.86 | 0.97 | 2.12 | 2.01 | 2.04 | 1.67 | 24.30 | 22.26 | 21.10 | 19.89 | 86 |
| CD(P=0.01) | 3.24 | 3.12 | 3.35 | NS | NS | NS | NS | NS | 94.50 | 86.56 | 82.06 | 77.36 | NS |

Note: Values in the parenthesis indicate arcsine transformed values

harvest observed in the present study. Similar findings were reported by MemenSurahman *et al.* (2015) in rice.

The growth regulator treatments also showed significant increase in the yield of maize hybrid GH-0727 by recording significantly higher yield parameters as compared to control (Table 1). The treatment with $GA_3$ (50 ppm) + IBA (100 ppm) recorded higher cob length (16.60 cm), cob girth (13.46 cm), number of rows per cob (17.33), number of seeds per row (29.33),yield per plant (72.37 g),yield per hectare (24.87 qha$^{-1}$,test weight (28.03 g) and shelling per cent (83.66),while lower values were recorded with control (12.63 cm, 10.13 cm, 12, 19, 65.72 g, 22.59 qha$^{-1}$, 22.53 g, and 77.33 %, respectively) (Table 1). The increase in the yield and yield parameters may be due to the activity of $GA_3$ and IBA. IBA increases the ability of cell division in meristematic region of plant and hence the ability of plant to absorb nutritive material will get enhanced which finally led to the increase in seed yield. $GA_3$ also increased the sink strength via increasing the length and growth rate of cells. Additionally, both growth regulators increased the strength of physiological source by increasing chlorophyll and effective age of leaves which finally lead to the increase of seed yield per unit area. Increase in test weight of the seeds was due to role of auxins, which plays an important role in formation of seeds and increase in transport of metabolic compounds to seeds. Higher shelling per cent was mainly due to higher seed weight and better development of seed (Arteca, 1996). Similar findings were also reported by, Gavino and Abon (2008) in rice,VahidGhodrat *et al*. (2012) in maize, Meena *et al*. (2014) in coriander and Somayeh Eskandari and Alireza Shokuhfar (2015) in wheat.

Among the treatments, $GA_3$ (50 ppm) + IBA (100 ppm) followed by $GA_3$ (75 ppm) + IBA (125 ppm) recorded higher seed quality parameters throughout the storage period (Table 2). Application of $GA_3$ (50 ppm) + IBA (100 ppm) recorded significantly higher germination (98.05 and 97.52 %) at first and second month of storage, respectively. There was no significant difference from third month to till the end of storage. Further, no significant difference was recorded in field emergence. Seedling vigour index was found significantly higher at first, second and third months of storage (3092, 2874 and 2493, respectively) and no significant difference from fourth month to till the end of storage. Higher germination observed in growth regulator treatment was due to synthesis of hydrolytic enzymes. These enzymes break down starch in the endosperm of seeds. The energy which is necessary for all metabolic processes is released which would provide initial energy for rapid germination. Such an increase in germination percentage due to application of growth regulators were reported by Pulok *et al*. (2015) in lentil and Meena *et al*., (2014) in cluster bean. Higher vigour index was noticed due to the action of growth regulator of $GA_3$which increased the growth rate of the cells in plumule and thus contributing to higher shoot length and on the other, IBA involved in cell division and cell elongation in radicle which attribute to higher root length. Higher seedling vigour index is mainly due to increase in germination (%), shoot length (cm) and root length (cm). Similar findings were also reported byVahidGhodrat*et al*. (2012) in maize and Arvindkumar *et al*. (2014) in bitter gourd. The present investigation revealed that foliar application of $GA_3$ (50 ppm) + IBA (100 ppm) enhanced field performance and seed yield of maize by 9.7 per cent which was on par with $GA_3$ (75 ppm) + IBA (125 ppm) as compared to control and can be effectively used in increasing single cross hybrid seed production in Maize.

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