Original article

Influence of Gibberellic Acid Application on Seed Production Quality of Female Line in Hybrid Rice (*Oryza sativa* L.)

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ABSTRACT: Currently, little information is available on the effects of Gibberellic acid (GA_3) application on Seed Production quality of hybrid rice after harvest. Therefore, an attempt was made in Rice Research and Training Center farm, Egypt to find out the optimum amount of Gibberellic acid during growth application for improving the seedling characters after harvesting of hybrid rice. The results indicated that, the maximum values of germination percent , germination index, root volume, root/shoot ratio, shoot length and root length were recorded by using by using 400 g/ha gibberellic acid during growth stage. Overall, it seems germination characters were promoted by application of GA_3 and could be beneficial for seed production of hybrid rice by enhancing seed quality (germination).

KEYWORDS Germination characteristics, Gibberellic acid, Hybrid rice.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important crops in the world. Due to the emphasis placed on early planting, rapid and uniform emergence, the quality of seed production is an important issue in rice (Wang et al., 2010; Cheng *et al*., 2013). Seed development, maturity and harvest management are critical considerations for maintaining high seed quality (Bewley *et al*., 2013). Efforts to meet the rice needs can be done in two ways: expanding the rice growing area and increasing productivity, or both. But in the future, expansion will be more difficult and expensive. Substantial improvement can be done through the adoption of hybrid rice (Nguyen, 2010; Hasan *et al*., 2015). Hybrid rice is considered as a viable alternative technology for breaking the present yield ceiling of modern varieties (Hasan *et al*., 2010).

Gibberellic acid (GA_3) or gibberellins comprise a group of naturally occurring plant hormones which play a central role in the early germination processes of seeds by activating enzyme production and mobilizing storage reserves (Bewley & Black, 1983). Application of GA_3 for hybrid rice seed production is the corner for poor storability of seeds produced as GA_3 induces á-amylase activity (Ponnuswamy and Prabagaran, 1997). While, the advantage of hybrid rice cannot be fully utilized unless a cost effective seed production system successfully developed. At present, use of Gibberellic acid (GA_3) is necessary for hybrid rice seed production, which increases the cost of hybrid seeds (Hasan *et al*., 2015). The use of lo-quality seeds is one of the major causes of low productivity of rice (Dahamarudin and Rivaie, 2013). Farmers generally use their own seeds from previous harvest stored in the improper storage and packaging conditions. So, various priming treatments have been developed to increase the speed and synchrony of seed germination (Sharifi and Khavazi, 2011).Therefore, the present study aims to standardize the optimum dose of GA_3 application during growth stage to improve the seed quality of hybrid rice seed production.

MATERIAL AND METHODS

Plant materials and Field treatments

The experiments were conducted at the Experimental Farm of Sakha Agricultural Research Station, Egypt, during the two successive summer seasons of 2013 and 2014.The methodologies have been followed as described previously by (Abo-youssef *et al*., 2015).The present study aimed to find out the effect of GA_3 on seed quality of hybrid rice F0 (hybrid rice seed production) after harvest. The material under study included two parental lines IR69625A (female line) with abortive sterility and Giza 179 R (restorer line) to produce F0 hybrid seed for promising hybrid SK.2151H. Experiment was designed with a split-plot following three replications. The row ratios (2R:8A, 2R:10A and 2R:12A) were in main plot and the doses of GA_3 (control, 300, 350, 400 g/ha) were in sub plots. The dosages of (GA_3) were applied in two sprayings of both A line and R line plants. As follows; first time: 40 % of GA_3 dosage was solved in a small amount of ethanol alcohol (70 %), and then it mixed with 50 liters of water and sprayed when 15-20 % of panicles were at heading (three days after heading of female parent). Second time: 60 % of GA_3 sprayed when 35-40 % of panicles were at heading (five days after heading of female parent).

The pre-germinated seed was uniformly broadcast in the nursery on three times for Giza179 R line (on 17th, 22nd and 27th May for both 2013 and 2014 seasons). Female sterile line IR69625A was sowed on 7th May of 2013 and 2014 seasons. The crop was grown as per recommended cultural practices for hybrid rice cultivation by (International rules for seed testing, (RRTC, 2011).

Data collected for Evaluation seedling characters after harvesting

After the harvesting; the samples were dried in sun to reduce moisture content to 13% and kept in cloth bag under ambient condition for germination studies during storage (nine months). A total of 100 healthy grains were surface- sterilized with 0.6% (6 g/L) sodium hypochlorite solution for 15 minutes and then rinsed three times with sterile distilled water. Seeds were germinated in a greenhouse for 21 days. They were considered to have germinated when the radical was longer than 2 mm (Cheng *et al*., 2014; Wang *et al*., 2014).The number of germinated seed was counted every day. Then, the germination percentage (GP) and germination index (GI) after 10 days of germination were calculated using the method described by Wang *et al.* (2010). A seedling was considered to be normal if the length of the shoot had reached at least half the length of the seed and if the length of the root had reached at least grain length.

Statistics Analyses: All data collected were subjected to analysis of variance according to Gomez and Gomez (1984). Treatment means were compared by Duncan's multiple range test (Ducan, 1955). All statistical analysis was performed using analysis of variance technique by means of "COSTAT" computer software package.

RESULTS AND DISCUSSION

Germination percentage

It was observed that different doses of GA_3 significantly influenced on germination percentage of hybrid rice seed. The highest values were 90.23 and 91.10% at 400 g GA_3 in 2013 and 2014 seasons, respectively. While, the lowest values were 85.63 and 86.20% at control in both seasons, respectively(Fig.1).Gibberellins facilitate germination process as providing formation of alfa-amylase enzyme which hydrolyzes the starch and transformation of starch to the sugar compounds, which could be used easily by embryo (Dunand,1993). In this concern, Abo-Youssef *et al*. (2010) reported that germination percent increased with increasing GA_3 dose up to 400g/ha when germination was conducted just after harvesting of the crop. But, with the advancement of storage period, the differences were more conspicuous. On the other hand, in another study,

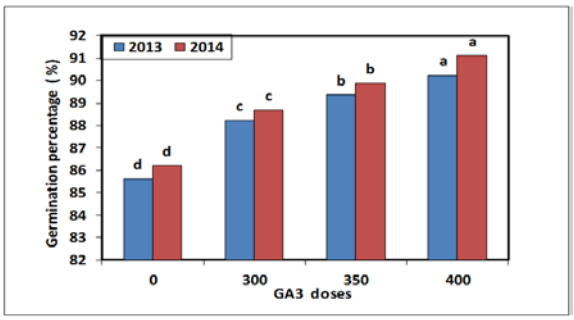

Fig. 1 Effect of GA_3 doses on germination percentage during 2013 and 2014 seasons.

Bars in each graph sharing the same letter(s) within a particular group of means in each character, are not significantly different at p = 0.05 according to Duncan's multiple range test.

Jagadeeswari *et al.* (2014) reported that GA_3 application increased viability and seed vigor index with increasing dose of GA_3 application, while there was drastic decrease in germination percentage. Thoithoi *et al*. (2014) observed that the germination percentage in early months of storage did not changed much in all the hybrid rice and application following GA_3 does not adversely affect seed quality but improved seed storability of hybrid rice. GA_3 is most frequently used to trigger seed germination (Yan *et al*., 2004). During the seed germination process, the gibberellins push

hydrolytic enzymes activities. This enzyme hydrolyzes starch and protein in the seed endosperm, which are food sources for embryonic development (Weiss and Ori, 2007). Miyoshi and Sato (1997), who studied the effects of gibberellins on the germination of indica and japonica rice and reported that there were stimulatory effects of gibberellins on the germination of indica and japonica rice seeds.

Germination index

A significant variation was found in terms of the germination index due to the application of different levels of GA_3. Among the different levels of GA_3, the highest germination index was found with 400 g GA_3 /ha in both season (Fig. 2). The highest values were 96.46 and 97.16% for the dose 400 g GA_3 in both seasons, respectively. These results were in compliance with those of Abo youssef et al. (2010) who found that, germination index increased by using gibberellic acid. Jagadeeswari *et al*. (2014) reported that the viability and seed vigor index increased with increasing dose of GA_3 application.

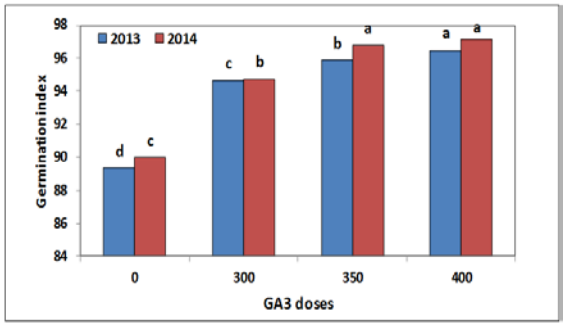

Fig. 2 Effect of GA_3 doses on germination index during 2013 and 2014 seasons. Bars in each graph sharing the same letter(s) within a particular group of means in each character, are not significantly different at p = 0.05 according to duncan's multiple range test.

Shoot length

The shoot lengths (cm) hybrid rice seedlings were significantly increased with the increasing of GA_3 doses (Fig. 3). The data indicated that the highest values were (15.03 and 15.36 cm) for the dose 400 g GA_3 during 2013 and 2014 seasons, respectively. But, the lowest values were (11.86 and 12.83 cm) without using GA_3 during 2013 and 2014 seasons, respectively. The data were agreement with those obtained by Abo Youssef et al. (2015) who found that shoot significantly increased by increasing GA_3 doses up to 400g/ha. Significant increase of plant growth with the exogenous application of GA_3 was also reported by earlier workers such as Kalavathi et al (2000), Yogesha et al. (2000) Thangaraj et al. (2000) and Tiwari et al. (2011) in rice. In another crop, it was found significant increase of plant growth with the exogenous application of antioxidants in another investigation; it was reported by (EL Sabagh *et al*. 2015, 2016). In contrast, it was reported that gibberellic acid application did not show significant effect on seedling length recorded in terms of shoot length in hybrid rice (Thoithoi et al. 2013), in maize seedlings (Tian *et al*. 2014).

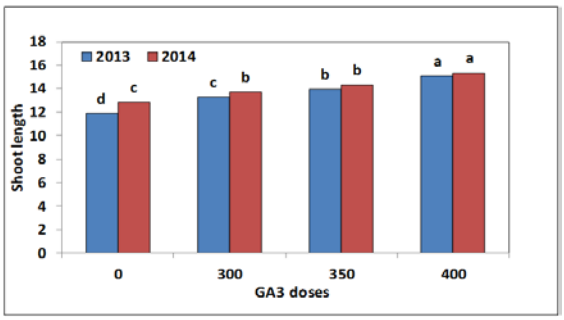

Fig. 3 Effect of GA_3 doses on shoot length (cm) during 2013 and 2014 seasons.
Bars in each graph sharing the same letter(s) within a particular group of means in each character, are not significantly different at p = 0.05 according to Duncan's multiple range test.

Root length

Data (Fig. 4) showed that there were highly significant differences of root length by using four levels of GA_3 application. The highest root lengths (10.33 cm and 10.90 cm) were observed under spraying of 400 g/ha GA_3 during 2013 and 2014 seasons, respectively.

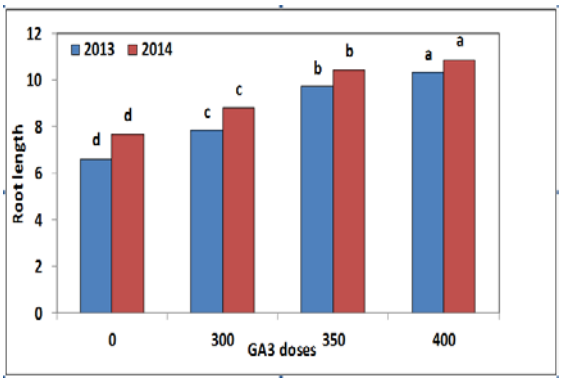

Fig. 4 Effect of GA_3 doses on root length (cm) during 2013 and 2014 seasons.
Bars in each graph sharing the same letter(s) within a particular group of means in each character, are not significantly different at p = 0.05 according to Duncan's multiple range test.

But the smallest root lengths were (6.63 and 7.70cm) recorded in control condition (without spraying GA_3) during 2013 and 2014 seasons, respectively. The data were agreement with those obtained by Abo Youssef *et al*. (2010) who found that root/shoot ratio significantly increased by increasing GA_3 doses up to 400g/ha. GA_3 increased

root elongation in the early stage of seedling growth of rice (Misra and Mohapatra, 1969). Mesocotyl and coleoptile elongation have been shown to be increased by GA_3 (Turner *et al*., 1982). While, Thoithoi *et al*. (2013) reported that gibberellic acid application did not show significant effect on the root length in hybrid rice seedlings.

CONCLUSION

It could be accomplished that, seedling characteristics were affected more by GA_3 application. Moreover, application of GA_3 remarkably improved seed quality by increasing germination percentage, germination index and early seedling growth. Overall, The best concentration (400g/ha) during Growth Stages on Seed Production Quality of the selected PGR (GA_3) has been established for the optimum performance of the most promising hybrid rice. Further, studies are need clarify whether these treatments has additive effects on the quality of rice seeds.

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