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Research Article – Plant Physiology

Effect of gibberellic acid and indole 3-acetic acid on seed germination performance of horse gram (*Macrotyloma uniflorum*) Lam (Verdc)

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Abstract

The experiment was undertaken with an objective to investigate the effect of various concentrations of plant growth regulators, i.e., Gibberellic acid (GA_3) and Indole 3-acetic acid (IAA) on seed germination of *Macrotyloma uniflorum*. Seeds were soaked for 12 hours in different concentrations substances (1.0, 2.0, 3.0 and 4.0 mg/L) of IAA, GA_3 and control set was soaked only in distilled water. Three replicates of each treatment with fifty seeds per replicate were arranged for precise physiological analysis. Significant variation was found in all aspects after analysis of variance (ANOVA) of each mean value. After two weeks of seed soaking, it was noted that germination percentages were significantly accelerated by lower concentrations (1 and 2 mg) of used hormones. Amongst the two potential growth regulators, 2 mg/L was found most effective because it showed highest germination percentage for IAA (93%) and GA_3 (88%). A great deal of information relating to seed germination practices shows that these plant growth regulators were efficient in overcoming dormancy leading to rapid seed germination. IAA was selected as best hormone in this study, which showed highest seed germination (93%).

Key words: Macrotyloma uniflorum, Gibberellic acid, Indole 3-acetic acid, Seed germination

Introduction

Horse gram (*Macrotyloma uniflorum* (Lam.) Verdc.) is an important drought-resistant pulse crop mainly grown in India, Africa, Australia, Burma, Malaysia and the West Indies (Jeswani and Baldev, 1990). Horse gram has been identified as a potential food resource of the tropics by the National Academy of Sciences of the USA (1979). The crop has good adaptability under adverse climatic conditions. It yields well on poor soils, it drought resistant, has high nitrogen fixation ability and also helps in soil conservation (Yadava and Vyas, 1994). It contains isoflavone dighlycoside, 5-hydroxy-7'3'4'- trime thoxy-8- methylisoflavone; 5-O—L-rhamnopyranosyl (12)-O-ß-D-glucopyranoside (Mitra et al., 1983). Seed germination can be controlled by many factors like natural germination (growth) inhibitors (Taiz and Zeiger, 2010). These are the derivatives of benzoic acid, cinnamic acid, coumarin, naringenin, jasmonic and abscisic acid (ABA). They interrupt gene expression or evoke enzyme inhibition; thus block the responses induced by any of several growth promoters (Karssen *et al.*, 1987).

The application of gibberellins increases the seed germination percentage by increase of the amino acid content in embryo and they cause release of hydrolytic enzyme required for digestion of endospermic starch when seeds renew growth at germination. The overall development of plant is regulated by the growth hormones, nutrient and environmental factors. They also vary in their germination requirement (Chauhan, 2010). It is not known in which concentrations these hormones will cause a response in the cell. This investigation with growth hormones will help in determining which of the hormonal concentration is suitable for seed germination and proper seedling growth. This analysis is considered necessary since the beneficial effect of presoaking treatment of seeds with plant growth regulator and

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other substances have been reported in the present literature repeatedly.

PGRs such as auxin and gibberellin include many aspects of plant growth and development. Also, they have important roles in many processes such as germination, seedling growth, product performance and yield and ripening (Al-Khassawaneh *et al.,* 2006). Seed priming with PGRs caused an increase in seed germination and seedling vigor (Chauhan *et al.,* 2009). Plant hormones are signal molecules produced at specific locations and regulate physiological processes in target cells at other locations in very low concentrations. The treatments with growth regulators probably antagonize the effect of growth inhibitory substance and also enhance rate of metabolism during germination (Verma and Tandon, 1988).

Material and Methods

The seeds of *Macrotyloma uniflorum* were obtained from Saravana store of Villupuram District in Tamil Nadu. Seeds were soaked for 12 hours under the different concentrations of plant growth substances (1.0, 2.0, 3.0 and 4.0 mg/L) of GA_3 and IAA and control set was soaked only in double distilled water. 50 seeds are sown in each row in above mentioned concentrations. Three replicates of fifty seeds were sown in sand medium. The two factorial experiments comprised of the growth regulators was laid out in randomized complete block design (RCBD). The concentrations of the test solutions used for the treatment were 1.0, 2.0, 3.0 and 4.0 mg/L for Gibberellic acid and Indole 3-acetic acid with a separate control check using the distilled water treatment (Table 1). Seed germination percentage was determined by the method given by Dahiya and Kumari (2007) after 14 days of treatment. Mean values were subjected to analysis of variance (ANOVA) to test the significance for germination percent as per the methodology advocated by Panse and Sukhatme (1967).

Results and Discussion

The analysis of variance (ANOVA) of germination data from growth regulators treated seeds indicated that they were all statistically significant ($P<0.05$). It also revealed that the value of coefficient of variation (CV %) ranges from 6.26 for control to 9.32 for IAA. The significant critical difference (CD) values indicate that *horse gram* cultivar was suitable for the treatments. The higher CD value indicates higher stability in that experimental environment (Roychowdhury and Tah, 2011; Roychowdhury and Tah, 2011b; Roychowdhury *et al.,* 2011) Here, IAA showed higher CD value (0.728), GA_3 showed moderate (0.623) and control represented lower CD value, i.e. 0.547. Moderate seed germination percentage was observed in Control set, i.e., 79% (Table 2). Amongst the used plant growth regulators, 2 mg concentration was found the most suitable because it showed the highest germination percentage for Indole 3-acetic acid (93%) and Gibberellic acid (88%).

The seeds treated with IAA showed significant difference to control. Germination percentage under the IAA treatment at 2 mg concentration (93%) was recorded as maximum. Both 3 and 4 mg/L concentration of IAA did not show any major difference in respect of germination that meant the higher concentration was not as good as the lower concentration; rather it decreased the germination percent. GA_3 in 4 mg concentration showed the least germination (76%). Observation showed that germination percent was increased from 1 mg to 2 mg treatments, while this parameter decreased when the concentrations were further increased up to 4 mg/L. This present study showed that growth regulator in higher concentrations inhibits the seed germination.

In the GA_3 and IAA treatments, plumule elongation was found in decreasing trend with the increase of hormonal concentration (data not shown). It was observed that for germination enhancement of *horse gram*, IAA with lower concentration was best suited, but in case of radicle and plumule elongation, these two hormones did not show any significant effect. When the germination percentage of three growth regulators were compared (Figure 1), IAA was observed more effective than GA_3 which was in accordance with Chakrabarti and Mukherji (2003) The application of NAA could increase the seed germination and other physiological activity by the reason of tolerance to the toxic effects/particles which was found in consistent with the finding of Hoque and Haque (2002).

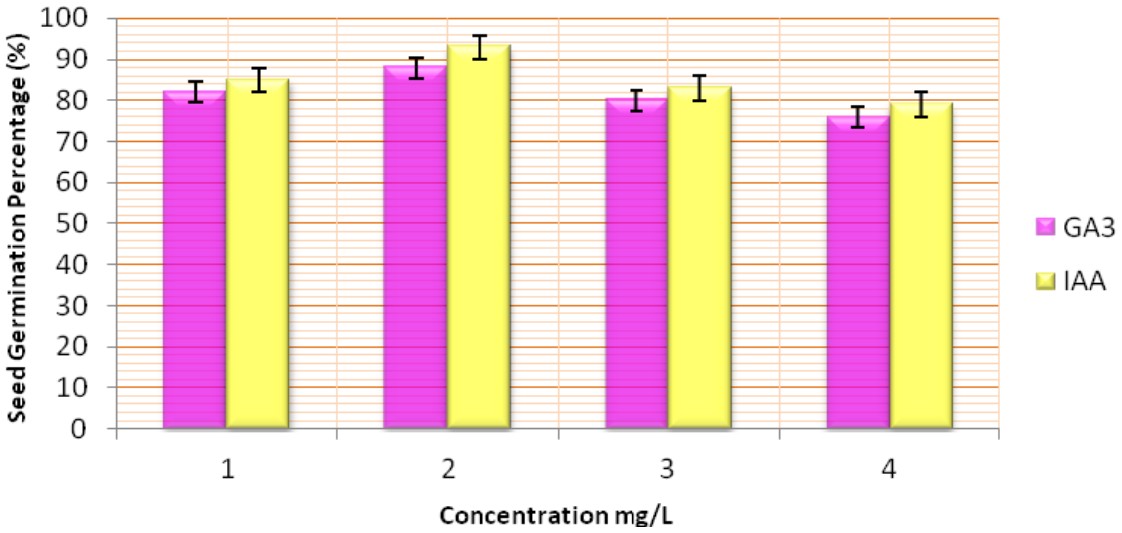
Table 1. The treatments of GA3 and IAA with their different concentrations

Treatments(h)	Growth hormone	Concentration(mg/L)	Seed soaked time (Hrs)
T_1 (Control)	-	-	12
T_2	GA_3	1.0	12
T_3		2.0	
T_4		3.0	
T_5		4.0	
T_6	IAA	1.0	12
T_7		2.0	
T_8		3.0	
T_9		4.0	

Table 2. The treatments of GA3 and IAA with the different concentrations

Treatments	Concentration (mg/L)	Germination Percent (%)	S.E (±)	C. D. (P<0.05)	C.V (%)
T_1 (Control)		79	0.186	0.547	6.26
T_2	1.0	82	0.158	0.623	7.28
T_3	2.0	88	0.147		
T_4	3.0	80	0.177		
T_5	4.0	76	0.165		
T_6	1.0	85	0.195	0.782	9.32
T_7	2.0	93	0.153		
T_8	3.0	83	0.175		
T_9	4.0	79	0.156		

Figure 1: Graphical representation showing the effect of GA3 and IAA with different on seed germination of *Macrotyloma uniflorum*



With the more effectiveness of low concentration of IAA (that is ratio of growth hormone and water) could restore retardation in water content; this may be able in tolerance to water stress. This result was considered in parallel to the findings of Das et al. (1994). The growth regulating substances may be acting to enhance the synthesis of enzyme proteins and thereby stimulate germination process. Growth regulators used in pre-sowing seed treatment play an important role in regulating germination and vigor. Treatment with high concentrations of GA_3 is effective in overcoming dormancy and causing rapid germination of seed. The germination substratum may be moisture with500 ppm solution of GA_3, when the dormancy is weaker, 200 ppm

may be enough. When it is stronger upto 1000 ppm solution may be used (Agrawal, 1994).

From the data presented in Table 2, it has been shown that IAA could overcome the adverse effects in *Macrotyloma uniflorum* better than GA_3 in the seed physiological activity, which supports the finding of Mikulik and Vinter (2002) The role of plant growth regulators in overcoming the harmful effects on growth may be due to the change in the endogenous growth regulators (Izumi and Hirasawa, 1996).

Conclusion

From the above discussion, it was concluded that IAA showed higher germination percentage in *Macrotyloma uniflorum* as compared to GA_3. Germination percentage was decreased with increased concentrations of the used plant growth regulators.

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