Sesame Germination and Dormancy Breaking Method Development

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Literature Review

Sesame Germination Method

According to the Association Official Seed Analysts (AOSA) Rules for Testing, Sesame seed (*Sesamum indicum*) shall be grown at 20-30° C, with a first and final count at 3 and 6 days, respectively. However, researchers have indicated that the optimum temperature for sesame germination is between 32 and 39°C (Carvalho et al. ,2001; Bakhshandeh et al.,2013). Tanesaka et al. notes that in their study, sesame germination was higher at 30°C or 35°C than at 25°C (2011). Not only are there contrasting views on the optimum growing temperature, but also on optimum dormancy breaking techniques for sesame seeds. Seed dormancy is a natural physiological state where seeds are prevented from germinating, even under favorable growing conditions. Breaking dormancy in sesame seeds is critical for accurate germination results, as viable seeds may be misevaluated as dead seeds.

Dormancy Breaking Techniques

Presoaking/Priming with Moistening Agents

Giberellic acid (GA_3) has been shown to break dormancy, however the optimum concentration varied across studies. Ashri and Palevitch found that presoaking seed for 48 hours completely broke dormancy in both 100 and 500 ppm treatments (1979). Shim et al. showed that seed priming could also be a viable option to improve sesame seed germination. Their study found that the best priming solution would be 200 mM solutions of either K_3PO_4 or PEG6000 (polyethylene glycol) for 4 days at 15C. This study found improvements in seed germination, though impacts were not significant at all treatment levels (2009).

Precondition Heat Treatments

Nyo et al. found heat treatments prior to warm germination tests (ISTA Rules) significantly improve germination of fresh and stored sesame seed by accelerating the after-ripening process. The heat treatments significantly broke dormancy and improved germination but did not completely break the dormancy in fresh seeds. After two months of storage the heat treatments were able to completely break dormancy. Both heat treatments used in the Nyo et al. study (2019) exceed the maximum temperature (45 – 47°C) of sesame seed recommended by Carvalho et al. (2001); and Bakhshandeh et al. (2013).

Scarification

In the Tanesaka et al. study, seed scarification improved germination of sesame seeds. Scarification was performed by cutting the edge of the seed opposite the radicle, exposing the cotyledon.

Research Objective

To investigate the optimum warm germination and dormancy breaking method for sesame seed, SoDak Labs analyzed the impact of a 10°C seven-day prechill, 30°C 48-hour precondition, the addition of 0.2% KNO_3 or 500 ppm of GA_3 as a moistening agent on the warm germination results of sesame seed. Additionally, the impact of scarifying swollen seeds identified on day six and extending the warm germination test to 8 days was investigated.

Material and Methods

Eight lots of sesame seeds were selected based on preliminary germination tests to allow for representation of various germination levels. Lot A, B, C, and D were harvested in 2020 and were received by Sodak Labs in mid-September of 2020. Lot E, F, G, and H were harvested in 2020 and were received by Sodak Labs in mid-January of 2021. Once received, all lots were stored at 10°C in a humidity-controlled environment until time of testing.

For each treatment, four replicates of 100 seeds of each lot were planted on top of blotter paper and grown in 20-30°C chambers with initial and final evaluations completed at three and six days per AOSA rules.

Research Study 1: *Impact of a precondition treatment and use of 0.2% KNO_3 or 500 ppm of GA_3 as a moistening agent on the germination for sesame seeds.*

Lots A, B, C, and D were selected and testing began in mid-October of 2020. Samples were either preconditioned at 30°C or stored at room temperature for 48 hours. These samples were then subsampled for the three moistening treatments (0.2% KNO_3, 500 ppm GA_3, Water).

Research Study 2: *Impact of temperature on warm germination results for sesame seed.*
Lots E, F, G, and H were selected and testing began in late January of 2021. Four replicates of 100 seeds from each lot were planted on top of blotter paper and grown in either 20-30°C or 30°C germinator chambers.

Research Study 3
Impact of a prechill treatment and use of 0.2% KNO_3 or 500 ppm of GA_3 as a moistening agent on warm germination results for sesame seeds.
Lots A, B, F, and H were selected and testing began in mid-February of 2021. Samples from each lot were subsampled for the three moistening agent treatments (0.2% KNO_3, 500 ppm GA_3, Water). Four replicates of each treatment were either prechilled for seven days at 10°C before movement to the 20-30°C chambers or were planted and directly grown in the 20-30°C.

Research Study 4
Impact of scarifying swollen seeds at day 6 and extending the length of a warm germination test for sesame seeds.
Lots A, B, F, and H were selected and testing began in mid-February of 2021. Samples from four sesame seed lots were subsampled for the three moistening agent treatments (0.2% KNO_3, 500 ppm GA_3, Water). Four replicates of each treatment were either prechilled for seven days at 10°C before movement to the 20-30°C chambers or were planted and directly grown in the 20-30°C. Swollen seeds identified at evaluation on day six were scarified and final evaluation was completed on day eight.

Results
Research Study 1
A treatment effect of moistening agents was observed (Table 1), where 500 ppm of GA_3 increased percent normal warm germination and decreased percent dead seeds compared to 0.2% KNO_3 and Water. No significant impact of treatment on percent abnormal seedling emergence was noted. Additionally, there was a significant precondition effect for percent abnormal seedling emergence and dead seed (Table 2), with a significant increase in percent abnormal seedling emergence and a significant decrease in percent dead seed for samples that were preconditioned compared to those that were not.

Table 1. Comparison of warm germination results of four sesame seed lots with either 0.2% KNO_3, 500 ppm GA_3 or water as a moistening agent

	%		
Treatment	Normal	Abnormal	Dead
0.2% KNO_3	83[b]	4	13[a]
500 ppm GA_3	87[a]	5	8[b]
Water	84[b]	4	12[a]
LSD	2.1	1.2	1.8

[1] values with different letters are statistically different (P<0.05)

Research Study 2:
Seed lots germinated at 20-30°C had a significantly increased percent normal warm germination and percent dead seed compared to germination at 30°C (Table 3). No impact was observed for percent abnormal warm germination at either temperature.

Table 2. Comparison of warm germination results of four sesame seed lots with or without a precondition

	%		
Precondition	Normal	Abnormal	Dead
None	85	3[b]	12[a]
Precondition	85	5[a]	10[b]
LSD	1.4	0.8	1.2

[1] values with different letters are statistically different (P<0.05)

Research Study 3
A treatment by prechill interaction was observed where a significant increase in percent normal and abnormal warm germination for the non-prechilled 500 ppm GA_3 and water treatments was observed compared to their respective chilled treatments (Table 4). Furthermore, a significant increase in dead seed for the prechilled 500 ppm GA_3 and water treatments was noted compared to their respective non- chilled treatments. There was no significant difference between the prechilled and non-prechilled 0.2% KNO_3 treatments, nor any statistical difference between the three moistening agents within the non-prechilled or chilled preconditions.

Table 3. Comparison of warm germination results for four sesame seeds lots grown at 20-30°C or 30°C

	%		
Temperature	Normal	Abnormal	Dead
20-30°C	66[a]	2	32[a]
30°C	58[b]	1	41[b]
LSD	7.6	0.7	7.8

[1] values with different letters are statistically different (P<0.05)

Table 4. Comparison of warm germination results of four sesame seed with or without a prechill and either 0.2% KNO_3, 500 ppm GA_3, or water as the moistening agent

	%					
	Normal		Abnormal		Dead	
Treatment[1]	None	Prechill	None	Prechill	None	Prechill
0.2% KNO_3	80 abc	78 bcd	5 ab	2 c	15 bc	20 ab
500 ppm GA_3	83 a	74 cd	6 a	3 c	11 c	23 a
Water	81 ab	73 d	4 bc	3 c	15 bc	24 a
LSD	5.2		1.8		5.2	

[1] values with different letters are statistically different (P<0.05)

Research Study 4

Scarifying swollen seeds at day six and extending the warm germination test to day eight significantly did not significantly impact percent normal and abnormal emergence nor dead seeds (Table 5).

Table 5. Comparison of warm germination results of four sesame seed lots on day six and eight after scarifying swollen seeds on day six.

	%		
Evaluation Day	Normal	Abnormal	Dead
6	78	4	18
8	79	4	17
LSD	1.4	0.5	1.4

[1] values with different letters are statistically different (P<0.05)

Discussion and Conclusion

Ashri and Palevitch found that presoaking seed for 48 hours with GA_3 at 500ppm broke dormancy (1979). SoDak Labs observed similar results in research study one but an improvement in warm germination with GA_3 as a moistening agent was not observed in study three. However, research study one was completed approximately one-month post-harvest, while the remaining studies were completed between four- and five-months post-harvest. The natural physiological dormancy of sesame seed may have dissipated with after-ripening and may not have been impacted by treatments for these studies. Ashri and Palevitch noted that in the Mexican cultivar Cola de Borrego, dormancy had disappeared six months post-harvest (1979).

Our research did not observe an improvement in warm germination results with a 30°C precondition. Research by Nyo et al. (2019) indicated that a precondition was more effective after two months post-harvest and may explain why no improvement in warm germination results was observed at SoDak Labs as samples were tested approximately one-month post-harvest. Additionally, the precondition temperature was 45-47°C for Nyo et al. (2019) compared to 30°C in our study.

Based on the results of the research completed, the use of 500 ppm GA_3 may be warranted as an effective mode for breaking dormancy to optimize warm germination results for sesame seed, predominantly in freshly harvested seed lots. We also noted the addition of a prechill, precondition, 0.2% KNO_3 as a moistening agent, and the scarification of swollen seeds on day six did not improve warm germination results for sesame seeds.

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