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Research Article

EFFECT OF OSMOPRIMING AND HYDROPRIMING ON SEEDLING TRAITS OF SOYBEAN

Shifa Ur Rahman[1], Muhammad Hammad Nadeem Tahir[1]*, Zulfiqar Ali[1], Fahim Nawaz[2], Sidra Jameel[1]
[1]*Institute of Plant Breeding and Biotechnology, MNS University of Agriculture, Multan.*
[2]*Department of Agronomy, MNS University of Agriculture, Multan.*
**Corresponding author: hammad.nadeem@mnsuam.edu.pk*

ABSTRACT

Soybean (*Glycine max* L.) is a legume crop used as a source of edible oil and protein around the world. It contains 30-45% protein and 15-24% oil and contains high percentage of unsaturated fatty acids and no cholesterol. Fifteen soybean genotypes collected from national and international sources were sown in petri dishes under lab conditions following completely randomized design in two factors factorial arrangement with three replications and four seed priming treatments. Seeds were treated with water, $CaCl_2$ (100mM), KNO_3 (100mM) and H_2O_2 (100mM). Statistical analysis revealed that differences among genotypes for germination percentage, emergence index, emergence rate index, radicle length and plumule length were significant. Treatments and interaction of genotypes with treatments were significant for radicle and plumule lengths and non-significant for germination percentage, emergence index and emergence rate index. Mean performance of genotypes 292 and 283 was better for most of the traits under study. Germination percentage, emergence rate index and emergence increased by application of H_2O_2 whereas radicle and plumule lengths decreased as compared to control.

Keywords: ***Glycine max*; Seed priming; Germination; Genetic variability,**

1. INTRODUCTION

Soybean (*Glycine max* L) is a legume crop used as a source of edible oil and protein around the world. It contains 38-42% protein and 18-25% oil contents and contains high percentage of unsaturated fatty acids and no cholesterol (Neelima *et al.* 2018). Edible oil has become a part and parcel of modern food system. Edible oil deficit has become a major challenge for the economy of Pakistan. Its local production is far below the consumption levels and there is a big gap between the two. During 2016-17, total availability of edible oils from all sources was 3.623 million tonnes, whereas the local production was 0.431 million tonnes (12%). Around 3.191 million tonnes vegetable oil was purchased from various countries to meet the demand (Pakistan Economic Survey. 2017-18). The difference in utilization and production can be reduced by increasing area under oilseed crops, evolving new high yielding varieties and cultivating alternate crops. Soybean is important due to high percentage of oil (18-25%) and protein (38-42%) contents present in its seed (Neelima *et al*. 2018). It can effectively be cultivated in Pakistan in both spring and fall seasons (Khan *et al*. 2011). Soybean growth and production is severely affected by poor crop establishment while high yield is associated with early vigor. Rapid germination can produce deep roots and prevent from different abiotic stresses that can result in better yield and good crop establishment (Ashraf and Foolad, 2005). Priming is a pre-sowing treatment of seed with water or different chemicals that allows seed to hydrate but without radicle emergence (Chen and Arora, 2012). Seed priming is a suitable method to enhance seed and

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seedling vigor, leading to better stand establishment and yield (Bruggink *et al*., 1999; Khalil *et al*., 2010). Following study was carried out to evaluate the effects of hydropriming and osmopriming of soybean seeds on germination and embryo growth parameters under laboratory condition.

2. MATERIAL AND METHODS

Research was conducted at MNS-University of Agriculture, Multan during spring season of 2018. Multan is located in southern part of Punjab province in Pakistan at 30.1575^0 latitude and 71.5249^0 longitude. It is characterized by arid climate with hot summers and cold winters with average maximum temperature 32°C, minimum temperature 17°C and rainfall 175mm per year. Experimental material consisted of 15 genotypes of soybean collected from United States Department of Agriculture (USDA) and National Agriculture Research Center (NARC) Islamabad. Soybean genotypes were sown in petri dishes with double layers of filter paper (each above and beneath seeds) using completely randomized design in two factors factorial arrangement with three replications and four priming treatments. Each genotype had five seeds per replication. Seeds were hydroprimed (with water) and osmoprimed (with chemicals) with treatments i.e. control (water), $CaCl_2$ (100mM), KNO_3 (100mM) and H_2O_2 (100mM). Treatments were applied at 5ml per petri dish after 0, 24, 48, 72, 96, 120, 168, 192 and 216 hours. Data were recorded from day 1 to 8 days after application of treatments for germinated seeds. Germination percentage, emergence index, emergence rate index, radicle and plumule length (cm) were recorded and were analyzed using analysis of variance following Steel *et al.* (1997).

2.1. Germination Percentage (%)

Following formula was used to calculate germination percentage.

$$\text{Germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Total seeds}} \times 100$$

2.2. Emergence Index

AOSA (1983) was followed to calculate EI.

$$\text{Emergence index} = \frac{\text{Number of emerged seeds}}{\text{Days of first count}} + - - - + \frac{\text{Number of emerged seeds}}{\text{Days of final count}}$$

2.3. Emergence Rate Index

Khan *et al.,* (2004) was followed to calculate ERI.

$$\text{Emergence rate index} = \frac{\text{Emergence Index (EI)}}{\text{Germination Percentage (G\%)}}$$

2.4. Plumule and Radicle lengths (cm)

Plumule and radicle lengths were measured using measuring scale from tip of root and shoot, respectively, to collar region of seed, and expressed in centimeters.

3. RESULTS

All the genotypes differed for recorded parameters significantly. Interaction of genotypes with treatments and treatments exhibited significant differences only for radicle and plumule lengths (Table 1). Mean performance of genotypes for traits studied is presented in Table 2. Germination percentage ranged from 0.01% to 78.22%, emergence rate index from 0.001 to 0.024, emergence index from 0.01 to 1.95, radicle length from 0.07cm to 0.97cm and plumule length from 0.25cm to 3.71cm. Genotype 292 exhibited maximum performance for all traits however genotype 283 had maximum performance for germination percentage and plumule length. Genotypes 207/6 and Wilkin exhibited lowest performance for all traits.

Table 1. Mean square values from analysis of variance for various traits of soybean genotypes

SOV	DF	Germination percentage	Emergence Index	Emergence Rate Index	Radicle Length	Plumule Length
Genotype (G)	14	6559.37**	2.50**	0.00044**	1.24**	21.38**
Treatment (T)	3	557.78	0.58	0.00016	2.49**	25.27**
G × T	42	308.19	0.41	0.00004	0.26**	2.82**
Error	88	332.12	0.61	0.00006	0.05	0.67

* *= significant at 0.01 probability level

SOV = Sources of variation, **DF** = Degrees of freedom,

Table 2. Mean performance of soybean genotypes for seedling traits across the seed priming treatments

Genotypes	Germination percentage (%)	Emergence Index	Emergence Rate Index	Radicle Length (cm)	Plumule Length (cm)
292	74.89 **a**	1.95 **a**	0.024 **a**	0.97 **a**	3.60 **a**
293	74.89 **a**	1.19 **b**	0.015 **bc**	0.63 **b**	3.21 **a**
283	78.22 **a**	1.19 **b**	0.015 **bc**	0.67 **ab**	3.71 **a**
301	74.89 **a**	1.12 **bc**	0.014 **bcd**	0.66 **b**	2.97 **ab**
44	48.22 **b**	0.83 **bcd**	0.019 **ab**	0.38 **bcd**	2.14 **bc**
203	48.22 **b**	0.62 **bcde**	0.012 **bcd**	0.56 **bc**	1.92 **cd**
NARC-2	38.22 **b**	0.61 **bcde**	0.014 **bcd**	0.14 **d**	1.15 **cde**
205/3	41.56 **b**	0.47 **cde**	0.009 **cde**	0.08 **d**	0.91 **de**
209	33.22 **bc**	0.46 **cde**	0.014 **bcd**	0.17 **d**	1.00 **de**
111	38.22 **b**	0.45 **cde**	0.008 **def**	0.27 **cd**	1.73 **cd**
Dawson	19.89 **cd**	0.24 **de**	0.004 **efg**	0.07 **d**	0.48 **e**
287	4.89 **de**	0.05 **e**	0.001 **fg**	0.08 **d**	0.33 **e**
11	3.22 **e**	0.03 **e**	0.001 **fg**	0.07 **d**	0.28 **e**
207/6	0.01 **e**	0.01 **e**	0.001 **g**	0.07 **d**	0.25 **e**
Wilkin	0.01 **e**	0.01 **e**	0.001 **g**	0.07 **d**	0.25 **e**

Osmopriming with H_2O_2 improved germination percentage (%) compared to other treatments (Hydropriming, $CaCl_2$, KNO_3) for most genotypes including 301, 111, Dawson, 287, 203, NARC-2, 11 and 205/3 (Fig 1). Osmopriming with H_2O_2 produced maximum emergence index compared to other treatments for genotypes 111, 287 203, NARC-2, 44, 11 and 205/3. Hydropriming and osmopriming with KNO_3 produced maximum emergence index compared to other treatments for genotypes 301, Dawson, 283, 293 and 292, 209, 44 respectively (Fig 2). Osmopriming with H_2O_2 produced maximum emergence rate index compared to other treatments for genotypes 301, 111, Dawson, 283, 203, NARC-2, 44, 205/3 and 293. Hydropriming and H_2O_2 produced maximum emergence rate index for genotypes 301, 111, Dawson, 283, NARC-2, 44, 205/3 and 293 (Fig 3). Hydropriming produced maximum radicle length compared to other treatments for genotype 301, 283, 203, 292, NARC-2, 44 and 293 whereas H_2O_2 produced maximum radicle length for genotypes 111, 203, 287, 209 and 44. KNO_3 produced maximum radicle length for genotype 205/3 (Fig 4). Hydropriming produced maximum plumule length compared to other treatments for genotypes 301, 111, 283, 203, 292, NARC-2, 44 and 293 whereas H_2O_2 produced maximum plumule length for Dawson, 287, 11 and 209 with $CaCl_2$ and KNO_3 producing maximum plumule length for 11 and 205/3 respectively (Fig 5).

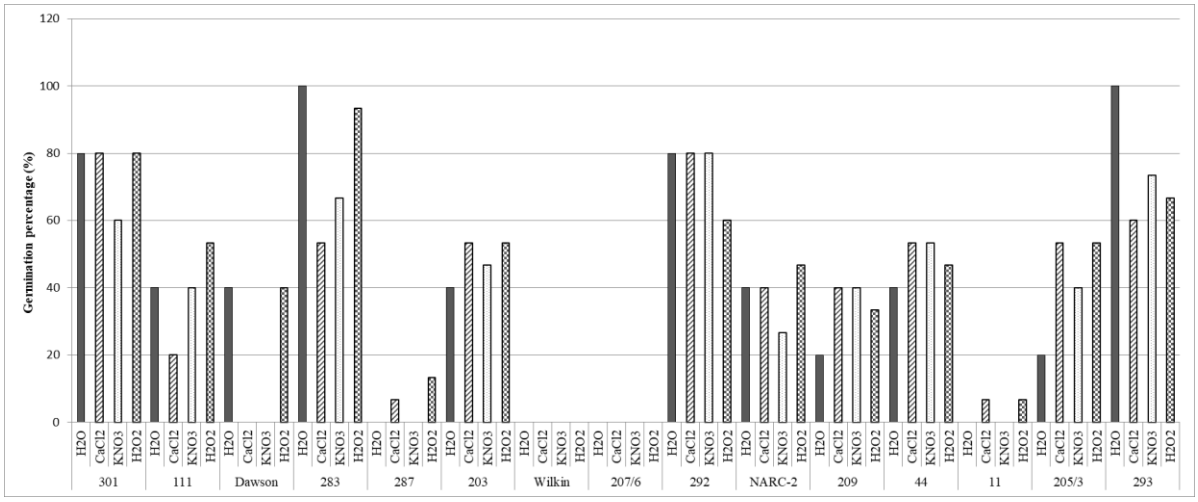

Fig. 1. Comparison of germination percentage of soybean genotypes with different priming treatments

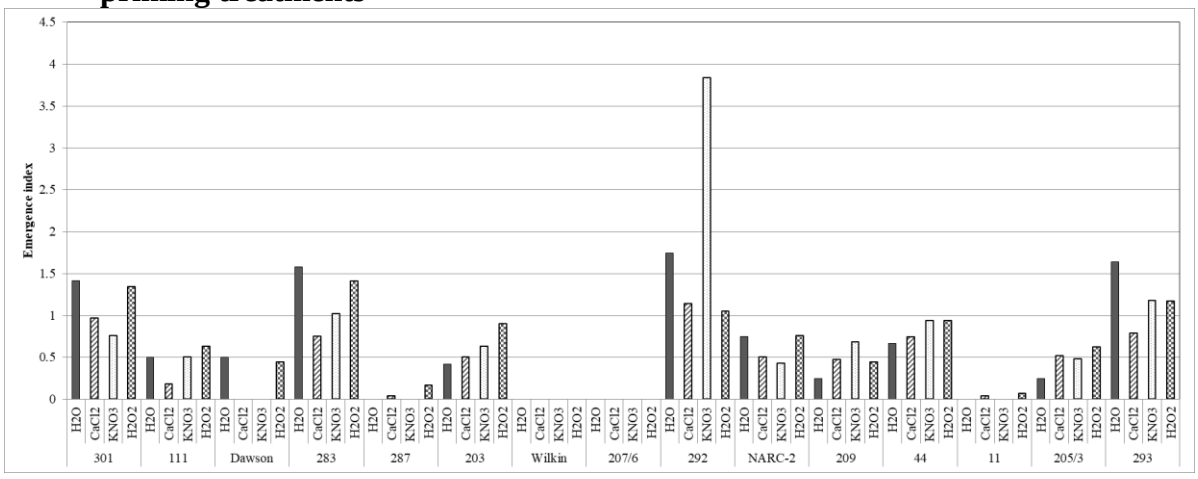

Fig. 2. Comparison of Emergence index of soybean genotypes with different priming treatments

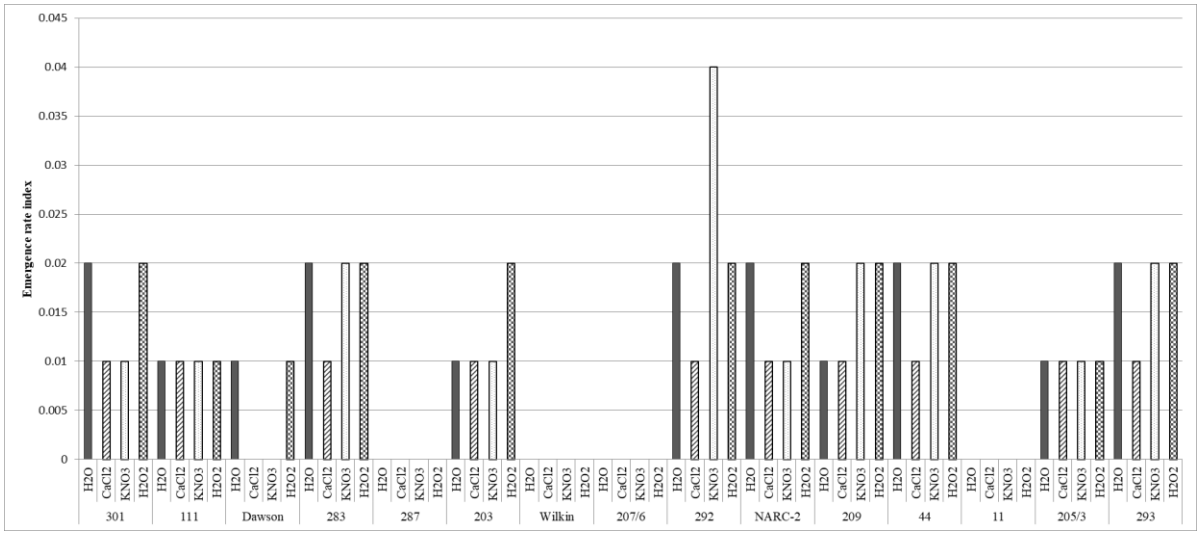

Fig. 3. Comparison of Emergence rate index of soybean genotypes with different priming treatments

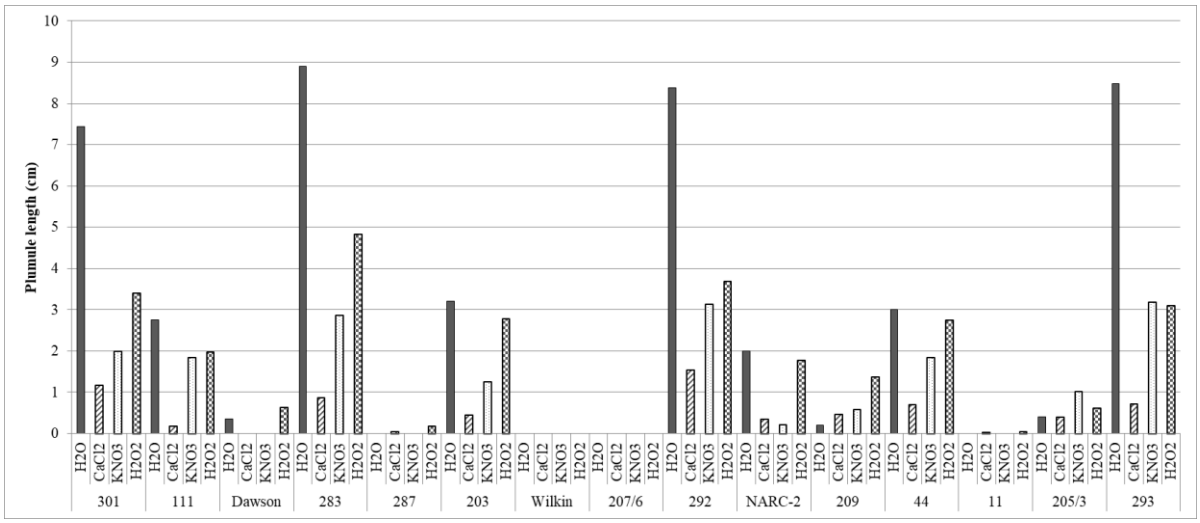

Fig. 4. Comparison of plumule length of soybean genotypes with different priming treatments

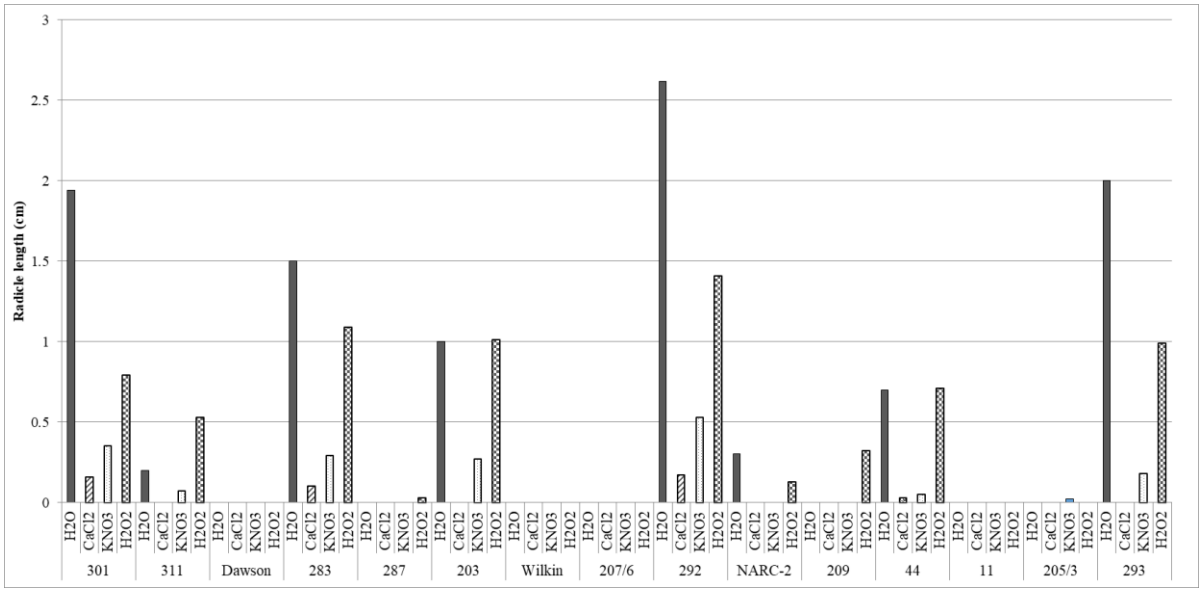

Fig. 5. Comparison of radicle length of soybean genotypes with different priming treatments

4. DISCUSSION

Significant differences among genotypes suggest that variability is present in breeding material so selection may be effective to improve studied traits. Genotypes 292 and 283 performed better for most of the traits including germination percentage, emergence index, emergence rate index and plumule so these genotypes may be used in breeding programs for further improvement of these traits.

Treatments and genotype × treatment interaction revealed that priming techniques were more effective for radicle and plumule growth than germination percentage, emergence index and emergence rate index. Furthermore, genotypes responded differently to priming treatments for plumule and radicle growth only suggesting that radicle and plumule growth may be enhanced through priming treatments to get a rapid and better crop stand (Farooq *et al.*, 2005). Ahmadvand *et al.*, (2012), Ghiyasi and Tajbakhsh, (2013), (zuffo *et al.*, 2017) and Sibande *et al.*,(2015) also observed significant differences among genotypes for these traits. Germination percentage ranged from 0.01% to 78.22%, emergence rate index from 0.001 to 0.024, emergence index from

0.01 to 1.95, radicle length from 0.07cm to 0.97cm and plumule length from 0.25cm to 3.71cm. Ranges for different traits reported in literature were: from 31% to 97% for germination percentage (Miladinov *et al.*, 2018; Sibande *et al.,* 2015; Golezani *et al.*, 2011;), from 13.70 to 35 for emergence index (sadeghi *et al.,* 2011; Ghiyasi and Tajbakhshi, 2013), from 26 to 50 for emergence rate index (zuffo *et al.,* 2017), from 2.6cm to 5.86cm for radicle length (Ahmadavand *et al.,* 2012; Sibande *et al.*, 2015) and from 2.9cm to 5.1cm for plumule length (Ahmadavand *et al.,* 2012). Ranges of germination percentage, emergence rate index, emergence index, radicle length and plumule length observed in present study are quite low from range reported in literature therefore present breeding material needs to be improved for these traits. Maximum germination percentage, emergence index and emergence rate index were observed by osmopriming with H_2O_2 however, Ahmadvand *et al.,* (2012) found maximum germination percentage with KNO_3. Hydropriming resulted in maximum plumule length in present study. Sibande *et al.,* (2015) also found maximum plumule length for hydroprimed seeds but Ahmadvand *et al.,* (2012) found maximum plumule length for KNO_3. Maximum radicle length was observed for hydropriming in present study. Sibande *et al.,* (2015) also found maximum radicle length in hydroprimed seeds however, Ahmadvand *et al.,* (2012) found maximum radicle length for KNO_3. These deviations in results might be due to varying conditions of lab, different germplasm and treatments.

5. Conclusion

The genotypes 292 and 283 had better performance for most of the traits under study. Therefore, these genotypes may be exploited in the soybean breeding programs for improved germination and embryo growth that may help to establish a good crop stand rapidly. Osmopriming with hydrogen peroxide exhibited best germination percentage, emergence index and emergence rate index for most of the genotypes. Hydropriming produced maximum radicle and plumule length for most of the genotypes followed by osmopriming with hydrogen peroxide. So in general, hydrogen peroxide may be used effectively to improve the germination percentage and speed of germination.

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