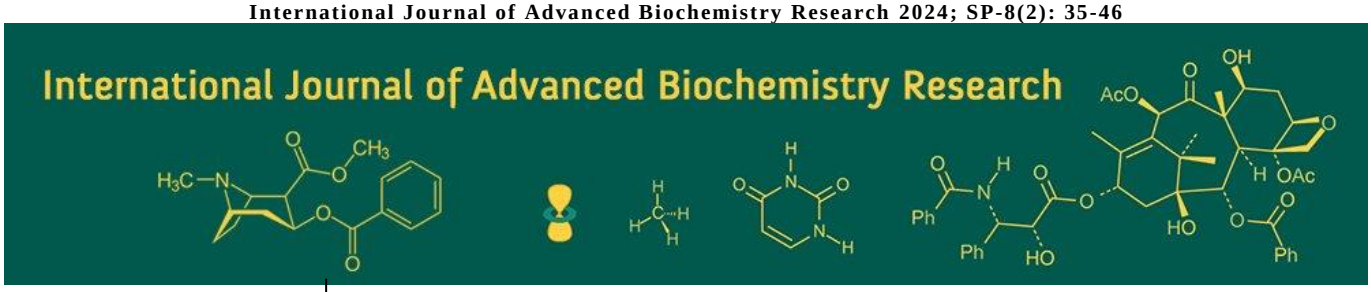

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Effect of antioxidant foliar application and harvesting stages on seed morphometry of soybean (*Glycine max* (L) Merr.)

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Abstract
The present study was carried out under the field and laboratory conditions at Post Graduate Institute Research Farm and Seed Technology Research Unit, Department of Agricultural Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S.) during *kharif* season 2017 and 2018. Two varieties of soybean *viz*., V1 - KDS-726, and V2 - KDS-344 were used for the study. The foliar spray with antioxidants *viz*., T1- Ascorbic acid (100 ppm), T2- Salicylic acid (100 ppm), T3- Humic acid (2000 ppm), T4- Pyridoxine (100 ppm), T5- Salicylic acid (100 ppm) + Ascorbic acid (100 ppm) along with T0- Control. The crop was harvested at three harvesting stages *viz*., H1- at physiological maturity, H2- 5th days after physiological maturity and H3- 10th days after physiological maturity. The harvested seeds were stored up to 360 days of storage. The field and laboratory experiment was conducted in Split Factorial Design with three replications. seed morphometry characteristics *viz*., length of seed (7.861 mm), width of seed (6.551 mm), area of seed (36.172 mm^2), seed diameter (5.383 mm), seed perimeter (30.356 mm) and seed roundness (93.972) were recorded in variety KDS-726 (V1) irrespective of foliar application of antioxidants and harvesting stages. The interaction of the soybean variety KDS-726 with foliar application of ascorbic acid @100 ppm and harvested at physiological maturity, found superior for seed morphometry characteristics *viz.*, length of seed (7.989 mm), width of seed (6.679 mm), area of seed (38.742 mm^2), seed diameter (5.675 mm), seed perimeter (31.501 mm) and seed roundness (95.041) as compared with other interactions.

Keywords: Morphometry, pyridoxine, physiological maturity, perimeter, roundness

Introduction
Soybean (*Glycine max* (L) Merr.) belongs to leguminous family ranked as a top oilseed crop, which provides approximately 50% edible oil of the world (Akparobi, 2009) [1]. It has been recognized as an ancient crop plant since the origin of agriculture (Jandong *et al.*, 2011) [8]. Due to the large amount of macro and micro nutrients, it has been considered as a nutritious food for human needs, livestock, industrial and medicinal purposes (Akparobi, 2009) [1]. Soybean seed consists of 18 to 25% oil and 30 to 50% protein. Protein of soybean seed contains amino acids required for human nutrition and livestock (Raei *et al.*, 2008) [11]. Salwa *et al.* (2011) [12] stated that soybean is a crop that compensates shortage of oil and protein of other crops.
Ascorbic acid is a natural product of plants functions play a key role as an antioxidant and an enzyme and apparently plays a role in ameliorating cofactor. It participates in a variety of processes. Ascorbic acid is associated with chloroplasts the oxidative stress of photosynthesis. In addition, AsA has a important roles in cell division and protein modification. One approach for inducing oxidative stress tolerance would to acts as a primary substrate in the cyclic pathway of enzymatic detoxification of hydrogen peroxide (Beltaji, 2008) [3]. Ascorbic acid application was also alleviated the destructive effects of salinity on osmotic potential, shoot and root dry mass, K+/Na+ ratio and contents of photosynthetic pigments in wheat seedlings under salinity stress was completely affected by exogenous ascorbic acid (Kaydan *et al.*, 2007) [9].
Humic acid is recognized as dark gold of agriculture. It is a major constituent of humic materials contributed the main essential elements of peat, coal and soil. It is extremely soluble in water and simply absorbed up by a plant as related to fertilizer because it has

frequent vigorous locations which mark it soluble in water. There is a rising attention in the use of humic acid as organic manures or soil tonic humic acids are widely used as fertilizers or plant growth stimulants, although their mechanism of action still remains partially unknown. Humic substances may be applied either directly to the soil or as foliar sprays. Despite both kind of application are commonly used in agricultural practices.

Pyridoxine is a form of vitamin B6. Vitamin B complex act as co-enzymes in the enzymatic reactions by which carbohydrates, fats and proteins are metabolized and involved in photosynthesis and respiration. Pyridoxine (Vitamin B6) is an essential metabolite in all organisms. It can act as a coenzyme for numerous metabolic enzymes and has recently been shown to be a potent antioxidant. It is an essential cofactor for numerous metabolic enzymes including amino acid metabolism and antibiotic biosynthesis and is a requirement for growth and differentiation of some plant species (Dolatabadian and Sanavy, 2008) [5].

Materials and Methods

Methodology

Experiments details

a) **Variety:** V1: Phule Sangam (KDS-726), V2: Phule Agrani (KDS-344)

b) **Treatments:** 1. (T0) Control, 2. (T1) Ascorbic acid (100 ppm), 3. (T2) Salicylic acid (100 ppm), 4. (T3) Humic acid (2000 ppm), 5. (T4) Pyridoxine (100 ppm), 6. (T5) Salicylic acid (100 ppm) + Ascorbic acid (100 ppm)

Harvesting stages: H1) At physiological maturity H2) 5 days after physiological maturity, H3) 10 days after physiological maturity

c) **Design:** Field and Lab:- Split Factorial, d) Replication: 3, e) Season: *Kharif* - 2017 and *Kharif* – 2018, f) Spacing: 30 x 10 cm, g) Plot size: Gross: 3.50 x 1.80 m^2, Net: 3.30 x 1.50 m^2, h) Seed;- For the present study, seeds of soybean varieties V1- KDS-726 and V2- KDS-344 were used. The seeds of two varieties were collected from Agricultural Research Station, Digraj, Dist.Sangali, MPKV, Rahuri. *Land Preparation;*- The soil of experimental plot selected for present studies was medium black with fairly uniform fertility. The experimental plot was ploughed followed by two harrowing. The stubbles, weeds and debris of previous crop was collected and removed from the experimental plot. Thus, plot was kept ready for sowing. *Manures and Fertilizer Application;*- The recommended package of practices by MPKV, Rahuri was followed to conduct the experiment. The fertilizer dose of 50 kg N and 75 kg P2O5 per hectare was applied in the form of diammonium phosphate (DAP), where in 45 kg of K per hectare was applied in the form of Muriate of potash (MOP) at the time of sowing. *Experimental Layout;*-The two experiments were laid out during *kharif,* 2017 and *Kharif,* 2018 at PGI Farm, MPKV, Rahuri in a Split Factorial design with three replications. *Sowing;*- The seeds of soybean variety V1- KDS-726 and V2- KDS-344 were sown by hand dibbling at 30 x 10 cm spacing in the plots. *Intercultural Operations and Aftercare;*- Two hand weeding were done at 15 and 35 days after sowing along with inter-cultivation and apt plant protection measures. *Foliar Application;*- Application of foliar spray of antioxidants was given at flower initiation stage and 2nd spray at 10 days after 1st spray.

Observation Recorded: Seed Morphometry (Image analysis);- The seed morphological characters were observed on Image Pro Vision Technology (Image Analyzer) are as below:

1 Length of seed (mm),
2 Width of seed (mm),
3 Area of seed (mm^2),
4 Seed Diameter (mm)
5 Seed perimeter (mm),
6 Seed roundness

The observations were taken from the seeds obtained at different harvesting stages. (H1) At physiological maturity, (H2) 5 days after physiological maturity and (H3) 10 days after physiological maturity.

Results and Discussion

Seed Morphometry (Image Analysis)

Length of Seed (mm): The data of length of seed (mm) as influenced by harvesting stages, varieties, foliar spray treatments and their interactions are presented in Table 1.

Effect of harvesting stages: From the Table 4, it was seen that the length of seed (mm) showed significant difference due to harvesting stages. The higher length of seed (mm) 7.451,7.447 and 7.449 (mm) was recorded at physiological maturity and the lower length of seed (mm) 6.979, 6.976 and 6.978 (mm) was recorded at 10 days after physiological maturity during the year 2017, 2018 and on pooled basis, respectively, irrespective of varieties and foliar spray treatments. *1.2 Effect of varieties;*- From the data, it was found that length of seed (mm) indicated significant differences due to the soybean varieties KDS-726 (V1) and KDS-344 (V2) during both years and on pooled basis (Table 1). The variety KDS-726 (V1) had significantly higher length of seed (mm) as 7.863, 7.859 and 7.861 (mm) than that of KDS-344 (V2) 6.593, 6.590 and 6.591 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and foliar spray treatments.*1.3 Effect of foliar spray treatments;*- The data regarding length of seed (mm) showed significant differences due to foliar spray treatment during both years and on pooled basis irrespective of harvesting stages and varieties. From the data, it was observed that the foliar spray with ascorbic acid (100 ppm) (T1) recorded maximum 7.302, 7.299 and 7.300 (mm) length of seed followed by pyridoxine (100 ppm) (T4) 7.288, 7.284 and 7.286 (mm) length of seed during the year 2017, 2018 and on pooled basis, respectively. While minimum length of seed (mm) was recorded in control 7.117, 7.114 and 7.116 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and varieties.

Effect of three factor interaction;- a) Interaction effect of harvesting stages, varieties and foliar spray treatments;- From the data, it was found that the interaction effects of harvesting stages, varieties and foliar spray treatments on length of seed (mm) of soybean was found significant during both years and on pooled basis are presented in Table 1. In the interaction effect of harvesting stages, varieties and

foliar spray treatments, maximum length of seed (mm) was recorded in interaction of H1V1T1 as 7.990, 7.987 and 7.989 (mm) followed by interaction H1V1T4 as 7.978, 7.975 and 7.977 (mm) during the year 2017, 2018 and on pooled basis, respectively. The minimum length of seed (mm) was recorded in interaction H3V2T0 as 6.143, 6.140 and 6.141 (mm) during the year 2017, 2018 and on pooled basis, respectively. Bademuqiqige *et al.* (2018) [2] found in *Seriphidium transiliense* harvest time had an influenced on the seed morphology, such as seed size, seed shape, seed length, seed width and seed moisture content, and these morphological characteristics maybe correlated with seed germination Teng *et al.* (2009) [14] in soybean, Canavar and Kaynak (2013) [4] in peanut, Havstad and Aamlid (2013) [6] in *Phleum pratense*, Jacobsen and Christiansen (2016) [7] in quinoa and Sintim *et al.* (2016) [13] in oil seed camelina.

Table 1: Effect of harvesting stages (H), varieties (V), foliar spray treatments (T) and their interactions on length of seed (mm)

Harvesting stages (H)	Length of seed (mm)		
	2017	**2018**	**Pooled**
H_1-At physiological maturity	7.451	7.447	7.449
H_2- 5 days after physiological maturity	7.253	7.250	7.251
H_3- 10 days after physiological maturity	6.979	6.976	6.978
SE (m) ±	0.017	0.015	0.019
CD at 5%	0.066	0.057	0.063
Varieties (V)			
V_1-KDS-726 (Phule Sangam)	7.863	7.859	7.861
V_2-KDS-344 (Phule Agrani)	6.593	6.590	6.591
SE (m) ±	0.0024	0.0028	0.0032
CD at 5%	0.0068	0.0079	0.0089
Treatments (T)			
T_0-Control	7.117	7.114	7.116
T_1-Ascorbic acid (100 ppm)	7.302	7.299	7.300
T_2-Salicylic acid (100 ppm)	7.136	7.132	7.134
T_3-Humic acid (2000 ppm)	7.253	7.250	7.251
T_4-Pyridoxine (100 ppm)	7.288	7.284	7.286
T_5-Salicylic acid (100 ppm) + Ascorbic acid (100 ppm)	7.271	7.268	7.270
SE (m) ±	0.004	0.005	0.006
CD at 5%	0.012	0.014	0.015
Harvesting stages × Variety interaction (H×V)			
H_1V_1	7.950	7.946	7.948
H_1V_2	6.952	6.948	6.950
H_2V_1	7.858	7.855	7.857
H_2V_2	6.648	6.645	6.646
H_3V_1	7.780	7.777	7.778
H_3V_2	6.179	6.176	6.178
SE (m) ±	0.004	0.005	0.006
CD at 5%	0.012	0.014	0.015
Harvesting stages × Treatment interaction (H×T)			
H_1T_0	7.402	7.398	7.400
H_1T_1	7.496	7.493	7.495
H_1T_2	7.423	7.418	7.421
H_1T_3	7.441	7.438	7.439
H_1T_4	7.483	7.480	7.482
H_1T_5	7.460	7.457	7.458
H_2T_0	7.008	7.005	7.007
H_2T_1	7.398	7.395	7.397
H_2T_2	7.024	7.021	7.022
H_2T_3	7.344	7.341	7.342
H_2T_4	7.380	7.377	7.379
H_2T_5	7.364	7.361	7.362
H_3T_0	6.942	6.939	6.940
H_3T_1	7.011	7.008	7.010
H_3T_2	6.960	6.957	6.959
H_3T_3	6.975	6.972	6.973
H_3T_4	6.999	6.996	6.998
H_3T_5	6.990	6.987	6.988
SE (m) ±	0.007	0.008	0.010
CD at 5%	0.020	0.024	0.027
Variety × Treatment interaction (V×T)			
V_1T_0	7.818	7.815	7.817
V_1T_1	7.902	7.899	7.901
V_1T_2	7.838	7.835	7.837
V_1T_3	7.854	7.851	7.853
V_1T_4	7.889	7.886	7.888

V_1T_5	7.873	7.870	7.872
V_2T_0	6.416	6.413	6.415
V_2T_1	6.702	6.698	6.700
V_2T_2	6.433	6.430	6.431
V_2T_3	6.652	6.648	6.650
V_2T_4	6.686	6.682	6.684
V_2T_5	6.669	6.666	6.667
SE (m) ±	0.0059	0.0068	0.0078
CD at 5%	0.0166	0.0193	0.0218
Harvesting stages × Variety × Treatment interaction (H×V×T)			
$H_1V_1T_0$	7.906	7.902	7.904
$H_1V_1T_1$	7.990	7.987	7.989
$H_1V_1T_2$	7.925	7.919	7.922
$H_1V_1T_3$	7.941	7.937	7.939
$H_1V_1T_4$	7.978	7.975	7.977
$H_1V_1T_5$	7.961	7.957	7.959
$H_1V_2T_0$	6.898	6.895	6.897
$H_1V_2T_1$	7.002	6.999	7.001
$H_1V_2T_2$	6.921	6.917	6.919
$H_1V_2T_3$	6.941	6.938	6.940
$H_1V_2T_4$	6.988	6.985	6.987
$H_1V_2T_5$	6.960	6.956	6.958
$H_2V_1T_0$	7.808	7.805	7.807
$H_2V_1T_1$	7.905	7.902	7.904
$H_2V_1T_2$	7.828	7.825	7.827
$H_2V_1T_3$	7.847	7.844	7.846
$H_2V_1T_4$	7.891	7.888	7.890
$H_2V_1T_5$	7.870	7.867	7.869
$H_2V_1T_0$	6.208	6.205	6.207
$H_2V_1T_1$	6.891	6.888	6.890
$H_2V_2T_2$	6.219	6.216	6.218
$H_2V_2T_3$	6.840	6.837	6.839
$H_2V_2T_4$	6.869	6.866	6.868
$H_2V_2T_5$	6.857	6.854	6.856
$H_3V_1T_0$	7.741	7.738	7.740
$H_3V_1T_1$	7.811	7.808	7.810
$H_3V_1T_2$	7.762	7.759	7.761
$H_3V_1T_3$	7.775	7.772	7.774
$H_3V_1T_4$	7.799	7.796	7.798
$H_3V_1T_5$	7.789	7.786	7.788
$H_3V_2T_0$	6.143	6.140	6.141
$H_3V_2T_1$	6.211	6.208	6.210
$H_3V_2T_2$	6.158	6.155	6.157
$H_3V_2T_3$	6.174	6.171	6.172
$H_3V_2T_4$	6.199	6.196	6.198
$H_3V_2T_5$	6.190	6.187	6.189
SE (m) ±	0.010	0.012	0.014
CD at 5%	0.029	0.033	0.038

Width of Seed (mm): The data of width of seed (mm) as influenced by harvesting stages, varieties, foliar spray treatments and their interactions are presented in Table 2.

Effect of harvesting stages: From the Table 2, it was seen that the width of seed (mm) showed significant difference due to harvesting stages. The higher width of seed (mm) 6.141, 6.137 and 6.139 (mm) was recorded at physiological maturity and the lower width of seed (mm) 5.669, 5.666 and 5.668 (mm) was recorded at 10 days after physiological maturity during the year 2017, 2018 and on pooled basis, respectively, irrespective of varieties and foliar spray treatments.

Effect of varieties: From the data, it was found that width of seed (mm) indicated significant differences due to the soybean varieties KDS-726 (V1) and KDS-344 (V2) during both years and on pooled basis (Table 2). The variety KDS-726 (V1) had significantly higher width of seed (mm) as 6.553, 6.549 and 6.551 (mm) than that of KDS-344 (V2) 5.283, 5.280 and 5.281 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and foliar spray treatments.

Effect of foliar spray treatments: The data regarding width of seed (mm) showed significant differences due to foliar spray treatment during both years and on pooled basis irrespective of harvesting stages and varieties. From the data, it was observed that the foliar spray with ascorbic acid (100 ppm) (T1) recorded maximum 5.992, 5.989 and 5.990 (mm) width of seed followed by pyridoxine (100 ppm) (T4) 5.978, 5.974 and 5.976 (mm) width of seed during the year 2017, 2018 and on pooled basis, respectively. While minimum width of seed (mm) was recorded in control 5.807, 5.804 and 5.806 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting

stages and varieties. Effect of three factor interaction;- a) Interaction effect of harvesting stages, varieties and foliar spray treatments;- From the data, it was found that the interaction effects of harvesting stages, varieties and foliar spray treatments on width of seed (mm) of soybean was found significant during both years and on pooled basis are presented in Table 2. In the interactions of harvesting stages, varieties and foliar spray treatments, maximum width of seed (mm) was recorded in interaction of H1V1T1 as 6.680, 6.677 and 6.679 (mm) followed by interaction H1V1T4 as 6.668, 6.665 and 6.667 (mm) during the year 2017, 2018 and on pooled basis, respectively. While minimum width of seed (mm) was recorded in interaction H3V2T0 as 4.833, 4.830 and 4.831 (mm) during the year 2017, 2018 and on pooled basis, respectively.

Area of Seed (mm^2): The data of area of seed (mm^2) as influenced by harvesting stages, varieties, foliar spray treatments and their interactions are presented in Table 2.

Effect of harvesting stages: From the Table 2, it was seen that the area of seed (mm^2) showed significant difference due to harvesting stages. The higher area of seed (mm^2) 35.446, 35.443 and 35.445 (mm^2) was recorded at physiological maturity (H1) and the lower area of seed (mm^2) 33.753, 33.750 and 33.751 (mm^2) was recorded at 10 days after physiological maturity (H3) during the year 2017, 2018 and on pooled basis, respectively, irrespective of varieties and foliar spray treatments. *3.2 Effect of varieties;-* From the data, it was found that area of seed (mm2) indicated significant differences due to the soybean varieties KDS-726 (V1) and KDS-344 (V2) during both years and on pooled basis (Table 2).The variety KDS-726 (V1) had significantly higher area of seed (mm^2) as 36.17, 36.17 and 36.172 (mm^2) than that of KDS-344 (V2) 32.736, 32.733 and 32.734 (mm^2) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and foliar spray treatments.

Effect of foliar spray treatments: The data regarding area of seed (mm^2) showed significant differences due to foliar spray treatment during both years and on pooled basis irrespective of harvesting stages and varieties. From the data, it was observed that the foliar spray with ascorbic acid (100 ppm) (T1) recorded maximum 34.883, 34.880 and 34.882 (mm^2) area of seed followed by pyridoxine (100 ppm) (T4) 34.681, 34.678 and 34.679 (mm2) area of seed during the year 2017, 2018 and on pooled basis, respectively. While minimum area of seed (mm^2) was recorded in control 33.928, 33.925 and 33.927 (mm^2) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and varieties.

Effect of three factor interaction;- a) Interaction effect of harvesting stages, varieties and foliar spray treatments

From the data, it was found that the interaction effects of harvesting stages, varieties and foliar spray treatments on area of seed (mm^2) of soybean was found significant during both years and on pooled basis are presented in Table 2. In the interactions of harvesting stages, varieties and foliar spray treatments, maximum area of seed (mm^2) was recorded in interaction of H1V1T1 as 38.744, 38.741 and 38.743 (mm^2) followed by interaction H1V1T4 as 38.073, 38.070 and 38.072 (mm^2) during the year 2017, 2018 and on pooled basis, respectively. The minimum area of seed (mm^2) was recorded in interaction H3V2T0 as 31.708, 31.705 and 31.707 (mm^2) during the year 2017, 2018 and on pooled basis, respectively. This might be due to soybean seed harvested at physiological maturity had maximum moisture and dry matter content. Nichal *et al.* (2018) [10] in soybean found that seed seed size were maximum at physiological maturity stage because all seed components has attained maximum values at physiological maturity stage and decreased at subsequent stages of harvesting after physiological maturity. Hence, it is advisable to harvest the soybean crop at physiological maturity stage.

Table 2: Effect of harvesting stages (H), varieties (V), foliar spray treatments (T) and their interactions on width of seed (mm) and area of seed (mm^2)

	Width of seed (mm)			Area of seed (mm^2)		
Harvesting stages (H)	**2017**	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
H_1-At physiological maturity	6.141	6.137	6.139	35.446	35.443	35.445
H_2- 5 days after physiological maturity	5.943	5.940	5.941	34.165	34.162	34.163
H_3- 10 days after physiological maturity	5.669	5.666	5.668	33.753	33.750	33.751
SE (m) ±	0.021	0.020	0.026	0.047	0.026	0.046
CD at 5%	0.084	0.080	0.083	0.184	0.100	0.150
Varieties(V)						
V_1-KDS-726 (Phule Sangam)	6.553	6.549	6.551	36.173	36.170	36.172
V_2-KDS-344 (Phule Agrani)	5.283	5.280	5.281	32.736	32.733	32.734
SE (m) ±	0.003	0.003	0.004	0.018	0.012	0.019
CD at 5%	0.008	0.009	0.011	0.050	0.035	0.052
Treatments (T)						
T_0-Control	5.807	5.804	5.806	33.928	33.925	33.927
T_1-Ascorbic acid (100 ppm)	5.992	5.989	5.990	34.883	34.880	34.882
T_2-Salicylic acid (100 ppm)	5.826	5.822	5.824	34.271	34.268	34.269
T_3-Humic acid (2000 ppm)	5.943	5.940	5.941	34.429	34.426	34.428
T_4-Pyridoxine (100 ppm)	5.978	5.974	5.976	34.681	34.678	34.679
T_5-Salicylic acid (100 ppm) + Ascorbic acid (100 ppm)	5.961	5.958	5.960	34.535	34.532	34.534
SE (m) ±	0.005	0.006	0.007	0.030	0.021	0.032
CD at 5%	0.015	0.016	0.019	0.086	0.060	0.090
Harvesting stages × Variety interaction (H×V)						
H_1V_1	6.640	6.636	6.638	37.499	37.496	37.497
H_1V_2	5.642	5.638	5.640	33.394	33.391	33.392

H_2V_1	6.548	6.545	6.547	35.710	35.707	35.708
H_2V_2	5.338	5.335	5.336	32.619	32.616	32.618
H_3V_1	6.470	6.467	6.468	35.311	35.308	35.310
H_3V_2	4.869	4.866	4.868	32.195	32.192	32.193
SE (m) ±	0.005	0.006	0.007	0.030	0.021	0.032
CD at 5%	0.015	0.016	0.019	0.086	0.060	0.090
Harvesting stages × Treatment interaction (H×T)						
H_1T_0	6.092	6.088	6.090	34.428	34.426	34.427
H_1T_1	6.186	6.183	6.185	36.205	36.202	36.204
H_1T_2	6.113	6.108	6.111	35.157	35.153	35.155
H_1T_3	6.131	6.128	6.129	35.471	35.469	35.470
H_1T_4	6.173	6.170	6.172	35.846	35.843	35.844
H_1T_5	6.150	6.147	6.148	35.571	35.567	35.569
H_2T_0	5.698	5.695	5.697	33.952	33.949	33.950
H_2T_1	6.088	6.085	6.087	34.419	34.416	34.418
H_2T_2	5.714	5.711	5.712	34.013	34.010	34.012
H_2T_3	6.034	6.031	6.032	34.084	34.081	34.082
H_2T_4	6.070	6.067	6.069	34.316	34.313	34.314
H_2T_5	6.054	6.051	6.052	34.204	34.201	34.202
H_3T_0	5.632	5.629	5.630	33.405	33.402	33.403
H_3T_1	5.701	5.698	5.700	34.025	34.022	34.023
H_3T_2	5.650	5.647	5.649	33.643	33.640	33.642
H_3T_3	5.665	5.662	5.663	33.733	33.730	33.732
H_3T_4	5.689	5.686	5.688	33.880	33.877	33.879
H_3T_5	5.680	5.677	5.678	33.832	33.829	33.830
SE (m) ±	0.009	0.010	0.012	0.053	0.037	0.056
CD at 5%	0.025	0.028	0.033	0.149	0.105	0.156
Variety × Treatment interaction (V×T)						
V_1T_0	6.508	6.505	6.507	35.530	35.528	35.529
V_1T_1	6.592	6.589	6.591	36.741	36.739	36.740
V_1T_2	6.528	6.525	6.527	35.960	35.956	35.958
V_1T_3	6.544	6.541	6.543	36.132	36.129	36.131
V_1T_4	6.579	6.576	6.578	36.442	36.439	36.441
V_1T_5	6.563	6.560	6.562	36.235	36.231	36.233
V_2T_0	5.106	5.103	5.105	32.326	32.323	32.325
V_2T_1	5.392	5.388	5.390	33.025	33.022	33.023
V_2T_2	5.123	5.120	5.121	32.582	32.579	32.581
V_2T_3	5.342	5.338	5.340	32.726	32.723	32.725
V_2T_4	5.376	5.372	5.374	32.919	32.916	32.918
V_2T_5	5.359	5.356	5.357	32.836	32.833	32.835
SE (m) ±	0.007	0.008	0.009	0.043	0.030	0.046
CD at 5%	0.021	0.023	0.027	0.122	0.085	0.128
Harvesting stages × Variety × Treatment interaction (H×V×T)						
$H_1V_1T_0$	6.057	6.592	6.594	35.974	35.973	35.973
$H_1V_1T_1$	6.680	6.677	6.679	38.744	38.741	38.742
$H_1V_1T_2$	6.615	6.609	6.612	37.158	37.152	37.155
$H_1V_1T_3$	6.631	6.627	6.629	37.487	37.485	37.486
$H_1V_1T_4$	6.668	6.665	6.667	38.072	38.070	38.071
$H_1V_1T_5$	6.651	6.647	6.649	37.558	37.555	37.557
$H_1V_2T_0$	5.588	5.585	5.587	32.882	32.879	32.881
$H_1V_2T_1$	5.692	5.689	5.691	33.667	33.664	33.665
$H_1V_2T_2$	5.611	5.607	5.609	33.156	33.153	33.155
$H_1V_2T_3$	5.631	5.628	5.630	33.455	33.452	33.453
$H_1V_2T_4$	5.678	5.675	5.677	33.619	33.616	33.618
$H_1V_2T_5$	5.650	5.646	5.648	33.583	33.580	33.582
$H_2V_1T_0$	6.498	6.495	6.497	35.515	35.512	35.514
$H_2V_1T_1$	6.595	6.592	6.594	35.963	35.960	35.962
$H_2V_1T_2$	6.518	6.515	6.517	35.545	35.542	35.544
$H_2V_1T_3$	6.537	6.534	6.536	35.632	35.629	35.630
$H_2V_1T_4$	6.581	6.578	6.580	35.845	35.842	35.844
$H_2V_1T_5$	6.560	6.557	6.559	35.759	35.756	35.758
$H_2V_1T_0$	4.898	4.895	4.897	32.388	32.385	32.387
$H_2V_1T_1$	5.581	5.578	5.580	32.875	32.872	32.874
$H_2V_2T_2$	4.909	4.906	4.908	32.482	32.479	32.480
$H_2V_2T_3$	5.530	5.527	5.529	32.536	32.533	32.534
$H_2V_2T_4$	5.559	5.556	5.558	32.786	32.783	32.785
$H_2V_2T_5$	5.547	5.544	5.546	32.649	32.646	32.647
$H_3V_1T_0$	6.431	6.428	6.430	35.101	35.098	35.100

$H_3V_1T_1$	6.501	6.498	6.500	35.518	35.515	35.516
$H_3V_1T_2$	6.452	6.449	6.451	35.177	35.174	35.176
$H_3V_1T_3$	6.465	6.462	6.464	35.277	35.274	35.276
$H_3V_1T_4$	6.489	6.486	6.488	35.408	35.405	35.407
$H_3V_1T_5$	6.479	6.476	6.478	35.386	35.383	35.385
$H_3V_2T_0$	4.833	4.830	4.831	31.708	31.705	31.707
$H_3V_2T_1$	4.901	4.898	4.900	32.532	32.529	32.531
$H_3V_2T_2$	4.848	4.845	4.847	32.109	32.106	32.107
$H_3V_2T_3$	4.864	4.861	4.862	32.189	32.186	32.188
$H_3V_2T_4$	4.889	4.886	4.888	32.352	32.349	32.350
$H_3V_2T_5$	4.880	4.877	4.879	32.277	32.274	32.276
SE (m) ±	0.013	0.014	0.016	0.075	0.052	0.079
CD at 5%	0.036	0.040	0.046	0.211	0.148	0.221

Seed Diameter (mm): The data of seed diameter (mm) as influenced by harvesting stages, varieties, foliar spray treatments and their interactions are presented in Table 3.

Effect of harvesting stages: From the Table 3, it was seen that the seed diameter (mm) showed significant difference due to harvesting stages. The higher seed diameter (mm) 5.484, 5.479 and 5.482 (mm) was recorded at physiological maturity (H1) and the lower seed diameter (mm) 5.194, 5.190 and 5.192 (mm) was recorded at 10 days after physiological maturity (H3) during the year 2017, 2018 and on pooled basis, respectively, irrespective of varieties and foliar spray treatments.

Effect of varieties: From the data, it was found that seed diameter (mm) indicated significant differences due to the soybean varieties KDS-726 (V1) and KDS-344 (V2) during both years and on pooled basis (Table 3). The variety KDS-726 (V1) had significantly higher seed diameter (mm) as 5.385, 5.381 and 5.383 (mm) than that of KDS-344 (V2) 5.262, 5.257 and 5.259 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and foliar spray treatments.

Effect of foliar spray treatments: The data regarding seed diameter (mm) showed significant differences due to foliar spray treatment during both years and on pooled basis irrespective of harvesting stages and varieties. From the data, it was observed that the foliar spray with ascorbic acid (100 ppm) (T1) recorded maximum 5.388, 5.384 and 5.386 (mm) seed diameter followed by pyridoxine (100 ppm) (T4) 5.363, 5.358 and 5.361 (mm) seed diameter during the year 2017, 2018 and on pooled basis, respectively. While minimum seed diameter (mm) was recorded in control (T0) 5.253, 5.249 and 5.251 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and varieties.

Effect of three factor interaction;- Interaction effect of harvesting stages, varieties and foliar spray treatments

From the data, it was obseved that the interaction effects of harvesting stages, varieties and foliar spray treatments on seed diameter (mm) of soybean was found significant during both years and on pooled basis are presented in Table 3. In the interaction effect of harvesting stages, varieties and foliar spray treatments, maximum seed diameter(mm) was recorded in interaction of H1V1T1 as 5.677, 5.672 and 5.675 (mm) followed by interaction H1V1T4 as 5.665, 5.660 and 5.663 (mm) during the year 2017, 2018 and on pooled basis, respectively. The minimum seed diameter (mm) was recorded in interaction H3V2T0 as 5.141, 5.137 and 5.139 (mm) during the year 2017, 2018 and on pooled basis, respectively

Seed Perimeter (mm): The data of seed perimeter (mm) as influenced by harvesting stages, varieties, foliar spray treatments and their interactions are presented in Table 3.

Effect of harvesting stages: From the Table 3, it was seen that the seed perimeter (mm) showed significant difference due to harvesting stages. The higher seed perimeter (mm) 30.154, 30.030 and 30.092 (mm) was recorded at physiological maturity (H1) and the lower seed perimeter (mm) 28.374, 28.250 and 28.312 (mm) was recorded at 10 days after physiological maturity (H3) during the year 2017, 2018 and on pooled basis, respectively, irrespective of varieties and foliar spray treatments.

Effect of varieties: From the data, it was found that seed perimeter (mm) indicated significant differences due to the soybean varieties KDS-726 (V1) and KDS-344 (V2) during both years and on pooled basis (Table 3). The variety KDS-726 (V1) had significantly higher seed perimeter (mm) as 30.418, 30.294 and 30.356 (mm) than that of KDS-344 (V2) 28.014, 27.890 and 27.952 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and foliar spray treatments.

Effect of foliar spray treatments: The data regarding seed perimeter (mm) showed significant differences due to foliar spray treatment during both years and on pooled basis irrespective of harvesting stages and varieties. From the data, it was observed that the foliar spray with ascorbic acid (100 ppm) (T1) recorded maximum 29.705, 29.702 and 29.582 (mm) seed perimeter followed by pyridoxine (100 ppm) (T4) 29.494, 29.370 and 29.432 (mm) seed perimeter during the year 2017, 2018 and on pooled basis, respectively. While minimum seed perimeter (mm) was recorded in control 28.774, 28.650 and 28.712 (mm) during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and varieties.

Effect of three factor interaction;- a) Interaction effect of harvesting stages, varieties and foliar spray treatments: From the data, it was revealed that the interaction effects of harvesting stages, varieties and foliar spray treatments on seed perimeter (mm) of soybean was found significant during both years and on pooled basis are presented in Table 3. In the interaction effect of harvesting stages, varieties and foliar spray treatments, maximum seed perimeter(mm) was recorded by the interaction of H1V1T1 as 31.563, 31.439 and 31.501 (mm) followed by interaction H1V1T4 as

31.527, 31.403 and 31.465 (mm) during the year 2017, 2018 and on pooled basis, respectively. The minimum seed perimeter (mm) was recorded in interaction H3V2T0 as 26.853, 26.729 and 26.791 (mm) during the year 2017, 2018 and on pooled basis, respectively.

Table 3: Effect of harvesting stages (H), varieties (V), foliar spray treatments (T) and their interactions on seed diameter (mm) and seed perimeter (mm)

	Seed diameter (mm)			Seed perimeter (mm)		
Harvesting stages (H)	**2017**	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
H_1-At physiological maturity	5.484	5.479	5.482	30.154	30.030	30.092
H_2- 5 days after physiological maturity	5.292	5.288	5.290	29.119	28.996	29.058
H_3- 10 days after physiological maturity	5.194	5.190	5.192	28.374	28.250	28.312
SE (m) ±	0.009	0.010	0.012	0.050	0.037	0.054
CD at 5%	0.036	0.040	0.039	0.197	0.144	0.175
Varieties(V)						
V_1-KDS-726 (Phule Sangam)	5.385	5.381	5.383	30.418	30.294	30.356
V_2-KDS-344 (Phule Agrani)	5.262	5.257	5.259	28.014	27.890	27.952
SE (m) ±	0.002	0.001	0.002	0.006	0.003	0.006
CD at 5%	0.007	0.003	0.006	0.016	0.010	0.016
Treatments (T)						
T_0-Control	5.253	5.249	5.251	28.774	28.650	28.712
T_1-Ascorbic acid (100 ppm)	5.388	5.384	5.386	29.705	29.582	29.644
T_2-Salicylic acid (100 ppm)	5.285	5.281	5.283	28.912	28.788	28.850
T_3-Humic acid (2000 ppm)	5.313	5.309	5.311	29.122	28.998	29.060
T_4-Pyridoxine (100 ppm)	5.363	5.358	5.361	29.494	29.370	29.432
T_5-Salicylic acid (100 ppm) + Ascorbic acid (100 ppm)	5.339	5.334	5.336	29.289	29.165	29.227
SE (m) ±	0.004	0.002	0.004	0.010	0.006	0.010
CD at 5%	0.011	0.005	0.011	0.028	0.017	0.028
Harvesting stages × Variety interaction (H×V)						
H_1V_1	5.586	5.581	5.584	31.207	31.082	31.144
H_1V_2	5.382	5.377	5.379	29.101	28.977	29.039
H_2V_1	5.343	5.339	5.341	30.402	30.279	30.341
H_2V_2	5.242	5.238	5.240	27.836	27.713	27.775
H_3V_1	5.227	5.223	5.225	29.645	29.521	29.583
H_3V_2	5.161	5.157	5.159	27.104	26.980	27.042
SE (m) ±	0.004	0.002	0.004	0.010	0.006	0.010
CD at 5%	0.011	0.005	0.011	0.028	0.017	0.028
Harvesting stages × Treatment interaction (H×T)						
H_1T_0	5.378	5.373	5.376	29.637	29.513	29.575
H_1T_1	5.571	5.566	5.568	30.750	30.626	30.688
H_1T_2	5.427	5.423	5.425	29.768	29.643	29.706
H_1T_3	5.487	5.482	5.484	30.017	29.893	29.955
H_1T_4	5.542	5.537	5.539	30.508	30.384	30.446
H_1T_5	5.499	5.495	5.497	30.243	30.119	30.181
H_2T_0	5.220	5.216	5.218	28.710	28.586	28.648
H_2T_1	5.367	5.363	5.365	29.618	29.494	29.556
H_2T_2	5.252	5.248	5.250	28.816	28.693	28.755
H_2T_3	5.267	5.263	5.265	29.015	28.891	28.953
H_2T_4	5.332	5.328	5.330	29.376	29.253	29.315
H_2T_5	5.318	5.314	5.316	29.181	29.058	29.120
H_3T_0	5.162	5.158	5.160	27.975	27.851	27.913
H_3T_1	5.228	5.224	5.226	28.748	28.624	28.686
H_3T_2	5.177	5.173	5.175	28.152	28.028	28.090
H_3T_3	5.186	5.182	5.184	28.333	28.209	28.271
H_3T_4	5.215	5.211	5.213	28.597	28.473	28.535
H_3T_5	5.199	5.195	5.197	28.442	28.318	28.380
SE (m) ±	0.007	0.003	0.007	0.017	0.010	0.017
CD at 5%	0.020	0.009	0.019	0.049	0.029	0.049
Variety × Treatment interaction (V×T)						
V_1T_0	5.298	5.294	5.296	29.980	29.856	29.918
V_1T_1	5.460	5.456	5.458	30.817	30.693	30.755
V_1T_2	5.340	5.336	5.338	30.205	30.080	30.143
V_1T_3	5.374	5.370	5.372	30.343	30.219	30.281
V_1T_4	5.434	5.430	5.432	30.675	30.552	30.614
V_1T_5	5.406	5.402	5.404	30.488	30.364	30.426
V_2T_0	5.207	5.203	5.205	27.568	27.444	27.506
V_2T_1	5.317	5.312	5.314	28.594	28.470	28.532
V_2T_2	5.231	5.226	5.228	27.619	27.495	27.557

V_2T_3	5.253	5.248	5.251	27.900	27.776	27.838
V_2T_4	5.291	5.287	5.289	28.312	28.188	28.250
V_2T_5	5.271	5.266	5.268	28.090	27.966	28.028
SE (m) ±	0.006	0.003	0.005	0.014	0.009	0.014
CD at 5%	0.016	0.007	0.015	0.040	0.024	0.040
Harvesting stages × Variety × Treatment interaction (H×V×T)						
$H_1V_1T_0$	5.466	5.461	5.463	30.770	30.646	30.708
$H_1V_1T_1$	5.677	5.672	5.675	31.563	31.439	31.501
$H_1V_1T_2$	5.524	5.519	5.522	30.970	30.843	30.906
$H_1V_1T_3$	5.584	5.579	5.582	31.097	30.973	31.035
$H_1V_1T_4$	5.665	5.660	5.663	31.527	31.403	31.465
$H_1V_1T_5$	5.600	5.595	5.598	31.313	31.189	31.251
$H_1V_2T_0$	5.290	5.285	5.288	28.504	28.379	28.442
$H_1V_2T_1$	5.464	5.460	5.462	29.937	29.813	29.875
$H_1V_2T_2$	5.330	5.326	5.328	28.567	28.443	28.505
$H_1V_2T_3$	5.389	5.385	5.387	28.937	28.813	28.875
$H_1V_2T_4$	5.418	5.413	5.416	29.490	29.366	29.428
$H_1V_2T_5$	5.399	5.394	5.396	29.173	29.049	29.111
$H_2V_1T_0$	5.248	5.244	5.246	30.073	29.949	30.011
$H_2V_1T_1$	5.443	5.439	5.441	30.763	30.639	30.701
$H_2V_1T_2$	5.291	5.287	5.289	30.230	30.106	30.168
$H_2V_1T_3$	5.309	5.305	5.307	30.303	30.179	30.241
$H_2V_1T_4$	5.387	5.383	5.385	30.596	30.473	30.535
$H_2V_1T_5$	5.378	5.374	5.376	30.450	30.326	30.388
$H_2V_1T_0$	5.191	5.187	5.189	27.346	27.223	27.285
$H_2V_1T_1$	5.290	5.286	5.288	28.473	28.349	28.411
$H_2V_2T_2$	5.212	5.208	5.210	27.403	27.279	27.341
$H_2V_2T_3$	5.225	5.221	5.223	27.726	27.603	27.665
$H_2V_2T_4$	5.276	5.272	5.274	28.156	28.033	28.095
$H_2V_2T_5$	5.257	5.253	5.255	27.913	27.789	27.851
$H_3V_1T_0$	5.182	5.178	5.180	29.097	28.973	29.035
$H_3V_1T_1$	5.259	5.255	5.257	30.123	29.999	30.061
$H_3V_1T_2$	5.204	5.200	5.202	29.417	29.293	29.355
$H_3V_1T_3$	5.228	5.224	5.226	29.630	29.506	29.568
$H_3V_1T_4$	5.250	5.246	5.248	29.903	29.779	29.841
$H_3V_1T_5$	5.241	5.237	5.239	29.700	29.576	29.638
$H_3V_2T_0$	5.141	5.137	5.139	26.853	26.729	26.791
$H_3V_2T_1$	5.196	5.192	5.194	27.373	27.249	27.311
$H_3V_2T_2$	5.150	5.146	5.148	26.887	26.763	26.825
$H_3V_2T_3$	5.143	5.139	5.141	27.037	26.913	26.975
$H_3V_2T_4$	5.180	5.176	5.178	27.290	27.166	27.228
$H_3V_2T_5$	5.156	5.152	5.154	27.183	27.059	27.121
SE (m) ±	0.010	0.004	0.009	0.024	0.015	0.025
CD at 5%	0.028	0.013	0.026	0.069	0.042	0.069

Seed Roundness

Effect of harvesting stages

From the Table 4, it was seen that the seed roundness showed significant difference due to harvesting stages. The higher seed roundness 94.371, 94.364 and 94.367 was recorded at physiological maturity (H1) and the lower seed roundness 92.993, 92.989 and 92.991 was recorded at 10 days after physiological maturity (H3) during the year 2017, 2018 and on pooled basis, respectively, irrespective of varieties and foliar spray treatments.

Effect of varieties: From the data, it was found that seed roundness indicated significant differences due to the soybean varieties KDS-726 (V1) and KDS-344 (V2) during both years and on pooled basis (Table 4). The variety KDS-726 (V1) had significantly higher seed roundness as 93.974, 93.970 and 93.972 than that of KDS-344 (V2) 93.332, 93.326 and 93.329 during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and foliar spray treatments.

Effect of foliar spray treatments: The data regarding seed roundness showed significant differences due to foliar spray treatment during both years and on pooled basis irrespective of harvesting stages and varieties. From the data, it was observed that the foliar spray of ascorbic acid (100 ppm) (T1) recorded maximum 93.969, 93.965 and 93.967 seed roundness followed by pyridoxine (100 ppm) (T4) 93.865, 93.861 and 93.863 seed roundness during the year 2017, 2018 and on pooled basis, respectively. While minimum seed roundness was recorded in control 93.284, 93.280 and 93.282 during the year 2017, 2018 and on pooled basis, respectively, irrespective of harvesting stages and varieties.

Effect of three factor interaction;- a) Interaction effect of harvesting stages, varieties and foliar spray treatments: From the data, it was revealed that the interaction effects of harvesting stages, varieties and foliar spray treatments on seed roundness of soybean was found significant during both years and on pooled basis are presented in Table 4. In the interaction effect of harvesting stages, varieties and

foliar spray treatments, maximum seed roundness was recorded in interaction of H1V1T1 as 95.043, 95.038 and 95.041 followed by interaction H1V1T4 as 94.943, 94.939 and 94.941 during the year 2017, 2018 and on pooled basis, respectively. The minimum seed roundness was recorded in interaction H3V2T0 as 92.343, 92.339 and 92.341 during the year 2017, 2018 and on pooled basis, respectively.

Table 4: Effect of harvesting stages (H), varieties (V), foliar spray treatments (T) and their interactions on seed roundness

	Seed roundness		
Harvesting stages (H)	2017	2018	Pooled
H_1-At physiological maturity	94.371	94.364	94.367
H_2- 5 days after physiological maturity	93.596	93.593	93.594
H_3- 10 days after physiological maturity	92.993	92.989	92.991
SE (m) ±	0.052	0.033	0.054
CD at 5%	0.205	0.131	0.175
Varieties(V)			
V_1-KDS-726 (Phule Sangam)	93.974	93.970	93.972
V_2-KDS-344 (Phule Agrani)	93.332	93.326	93.329
SE (m) ±	0.006	0.003	0.006
CD at 5%	0.017	0.009	0.016
Treatments (T)			
T_0-Control	93.284	93.280	93.282
T_1-Ascorbic acid (100 ppm)	93.969	93.965	93.967
T_2-Salicylic acid (100 ppm)	93.426	93.422	93.424
T_3-Humic acid (2000 ppm)	93.607	93.603	93.605
T_4-Pyridoxine (100 ppm)	93.865	93.861	93.863
T_5-Salicylic acid (100 ppm) + Ascorbic acid (100 ppm)	93.769	93.760	93.765
SE (m) ±	0.010	0.006	0.010
CD at 5%	0.029	0.016	0.028
Harvesting stages × Variety interaction (H×V)			
H_1V_1	94.724	94.719	94.722
H_1V_2	94.017	94.008	94.012
H_2V_1	93.920	93.917	93.918
H_2V_2	93.272	93.269	93.271
H_3V_1	93.279	93.275	93.277
H_3V_2	92.707	92.703	92.705
SE (m) ±	0.010	0.006	0.010
CD at 5%	0.029	0.016	0.028
Harvesting stages × Treatment interaction (H×T)			
H_1T_0	93.958	93.954	93.956
H_1T_1	94.707	94.702	94.704
H_1T_2	94.097	94.093	94.095
H_1T_3	94.333	94.329	94.331
H_1T_4	94.620	94.616	94.618
H_1T_5	94.508	94.488	94.498
H_2T_0	93.218	93.214	93.216
H_2T_1	93.948	93.944	93.946
H_2T_2	93.365	93.361	93.363
H_2T_3	93.515	93.511	93.513
H_2T_4	93.823	93.819	93.821
H_2T_5	93.710	93.706	93.708
H_3T_0	92.675	92.671	92.673
H_3T_1	93.252	93.248	93.250
H_3T_2	92.817	92.813	92.815
H_3T_3	92.972	92.968	92.970
H_3T_4	93.152	93.148	93.150
H_3T_5	93.090	93.086	93.088
SE (m) ±	0.018	0.010	0.018
CD at 5%	0.051	0.027	0.049
Variety × Treatment interaction (V×T)			
V_1T_0	93.585	93.581	93.583
V_1T_1	94.269	94.264	94.267
V_1T_2	93.757	93.753	93.755
V_1T_3	93.944	93.940	93.942
V_1T_4	94.191	94.187	94.189
V_1T_5	94.100	94.096	94.098
V_2T_0	92.982	92.978	92.980
V_2T_1	93.669	93.665	93.667
V_2T_2	93.095	93.092	93.094
V_2T_3	93.269	93.265	93.267

V_2T_4	93.539	93.535	93.537
V_2T_5	93.439	93.424	93.431
SE (m) ±	0.015	0.008	0.014
CD at 5%	0.041	0.022	0.040
Harvesting stages × Variety × Treatment interaction (H×V×T)			
$H_1V_1T_0$	94.317	94.311	94.314
$H_1V_1T_1$	95.043	95.038	95.041
$H_1V_1T_2$	94.500	94.496	94.498
$H_1V_1T_3$	94.690	94.686	94.688
$H_1V_1T_4$	94.943	94.939	94.941
$H_1V_1T_5$	94.850	94.846	94.848
$H_1V_2T_0$	93.600	93.596	93.598
$H_1V_2T_1$	94.370	94.366	94.368
$H_1V_2T_2$	93.693	93.689	93.691
$H_1V_2T_3$	93.977	93.973	93.975
$H_1V_2T_4$	94.297	94.293	94.295
$H_1V_2T_5$	94.167	94.129	94.148
$H_2V_1T_0$	93.433	93.429	93.431
$H_2V_1T_1$	94.303	94.299	94.301
$H_2V_1T_2$	93.626	93.623	93.625
$H_2V_1T_3$	93.833	93.829	93.831
$H_2V_1T_4$	94.226	94.223	94.225
$H_2V_1T_5$	94.100	94.096	94.098
$H_2V_1T_0$	93.003	92.999	93.001
$H_2V_1T_1$	93.593	93.589	93.591
$H_2V_2T_2$	93.103	93.099	93.101
$H_2V_2T_3$	93.196	93.193	93.194
$H_2V_2T_4$	93.420	93.416	93.418
$H_2V_2T_5$	93.320	93.316	93.318
$H_3V_1T_0$	93.007	93.003	93.005
$H_3V_1T_1$	93.460	93.456	93.458
$H_3V_1T_2$	93.143	93.139	93.141
$H_3V_1T_3$	93.310	93.306	93.308
$H_3V_1T_4$	93.403	93.399	93.401
$H_3V_1T_5$	93.350	93.346	93.348
$H_3V_2T_0$	92.343	92.339	92.341
$H_3V_2T_1$	93.043	93.039	93.041
$H_3V_2T_2$	92.490	92.486	92.488
$H_3V_2T_3$	92.633	92.629	92.631
$H_3V_2T_4$	92.900	92.896	92.898
$H_3V_2T_5$	92.830	92.826	92.828
SE (m) ±	0.025	0.014	0.025
CD at 5%	0.071	0.039	0.070

From the investigation, it can be concluded that the soybean varieties harvested at physiological maturity (H1) given better response to foliar spray with ascorbic acid @ 100 ppm and pyridoxine @ 100 ppm for seed morphometry parameters.

Conclusion

The document extensively discusses the effects of antioxidant foliar application and different harvesting stages on the morphometry of soybean seeds. It presents detailed results on how these factors influence various seed characteristics such as length, width, area, diameter, and perimeter. The study highlights the significant impact of antioxidant treatments and optimal harvesting times on enhancing seed quality, suggesting that such agricultural practices can effectively improve soybean seed characteristics. The findings contribute valuable insights for optimizing soybean production through strategic antioxidant use and timing of harvest.

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