The Pharma Innovation Journal 2019; 8(5): 67-73

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(5): 67-73

www.thepharmajournal.com
Received: 20-03-2019
Accepted: 21-04-2019

Venkatesh B
Ph.D (Scholar), Department of Seed Science and Technology, Karnataka, India

Basave Gowda
Special officer (Seeds), Seed Unit, UAS, Raichur, Karnataka, India

SN Vasudevan
Associate Director of Research, ZARS, VC, Farm, Mandya, GKVK, Bangalore, Karnataka, India

CR Konda
Professor and Head (ARS. Bidar), UAS, Raichur, Karnataka, India

Gururaj Sunkad
Professor and Head, Dept. of Plant Pathology, UAS, Raichur, Karnataka, India

SR Doddagoudar
Assistant Professor, Dept. of Seed Science and Technology, UAS, Raichur, Karnataka, India

K Lokesh
Assistant Professor, Dept. of Seed Science and Technology, COA, Kalaburagi, UAS, Raichur, Karnataka, India

Correspondence
Venkatesh B
Ph.D (Scholar), Department of Seed Science and Technology, Karnataka, India

Impact of offseason climate with different planting dates on seed quality parameters of soybean (*Glycine max* L. Merrill) cultivars

Venkatesh B, Basave Gowda, SN Vasudevan, CR Konda, Gururaj Sunkad, SR Doddagoudar and K Lokesh

Abstract
A laboratory study was conducted during 2015-16 and 2016-17 at seed unit laboratory, UAS, Raichur to find out the cultivars response in terms of seedling vigour and biochemical activities to assess the suitable planting dates for quality seed production. In order to explain the effect of sowing date on soybean (*Glycine max* L. Merrill) seed quality parameter, two varieties including JS 335 and DSb 21 were sown from Nov 1st fortnight, Nov 2nd fortnight, Dec 1st fortnight, Dec 2nd fortnight, Jan 1st fortnight, Jan 2nd fortnight, Feb 1st fortnight, Feb 2nd fortnight. The results of the experiment revealed that the below parameters significantly affected by sowing dates. The highest germination percentage (91.25%), shoot length (21.32 cm), root length (20.17 cm), seedling length (41.49 cm), seedling dry weight (121.23 mg), peak value of germination (39.83), alpha amylase activity (25.20 mm), Dehydrogenase activity (1.1.05 OD value), electrical conductivity (0.486 dSm^{-1}), seedling vigour index- I (3789) and seedling vigour index- II (11065) were recorded for crop sown in Nov 1st fortnight. It was noticed that sowing date significantly affected the seed quality parameters and seeds from early sowings (Nov 1st fortnight sowing) had the good seed quality.

Keywords: *Glycine max* L. Merrill, parameters of soybean

Introduction
Soybean (*Glycine max* L. Merrill) is an important oil seed crop in the world contributing 25 per cent to the global vegetable oil production and also serving as the major source of protein (40 %) and oil (20 %) for both human and animal consumption. Globally, it is grown in an area of about 120 million ha with a production of 351 million tonnes and productivity of 2920 kg per ha. Though it is comparatively new crop to India, it occupies an area of 11.40 million ha with a production of 12 million tonnes and productivity of 1010 kg per ha. In Karnataka, it is grown in an area of 3.2 lakh hectares with an annual production of 2.54 lakh tonnes and productivity of 785 kg per ha (Anon., 2017) [2].

Generally, the time of planting varies depending on the climatic conditions of the region and the variety to be grown. Different varieties of soybean are sensitive to changes in environmental conditions where the crop is being grown. Therefore, it is necessary to study the genotype × environment interaction to identify the varieties which are stable in different environments (Calvino *et al*., 2003) [5]. Heydecker (1972) [12] outlined a number of distinct determinants that influence seed vigour and viability. These include genetic factors, pre-harvest and maturational effects, mechanical factors during harvesting, storage conditions, intrinsic seed factors and pathological factors. Many of the above factors have been well documented by various researchers. Environmental factors during seed maturation have been less documented but have been shown to have a strong influence on seed germinability and seedling vigour (Fischer *et al*. 1988; Welbaun *et al*. 1990; Galau *et al*. 1988) [7, 29, 9].

Environmental factors impact on seed developmental stages that directly influences on seed vigour. At the time of growing season, higher temperature can directly impact on seed quality i.e., during seed formation, pod filling and maturation. Seed development is especially sensitive to high temperatures during the early pod set stages, as elevated temperatures during pod set reduce seed weight, thereby reducing quality and higher temperature during post flowering period can reduce seed germination ability and size of the seed (Egli *et al*., 2005) [6]. Seed germination and vigour rapidly decreased in seeds exposed to adverse environmental conditions.

When parental plants are exposed to high temperature during growth and development the quality of seed is highly influenced (Hasan *et al.* 2013) [10]. Soybean cultivars also respond differently to environmental stress, such as high temperature during the growing season, resulting in differences in seed vigour (Bradley *et al*., 2002) [4].

Seed quality aspect was seed viability, which can be measured by standard seed germination. Seed germination is a seed test that measures a seed lots ability to emerge and develop under ideal growing conditions, and predict the environmental and field conditions to seed emergence (TeKrony and Egli, 1977). Seed vigour is defined as the ability of seed to emerge and develop normal seedlings uniformly under (Ashton *et al*., 2007; Mc Donald and Phaneendranath, 1978) [3, 19]. Seed vigour can be measured by a variety of methods including accelerated aging, electrical conductivity, speed of germination count, and in some cases, indices that combine these measurements to more accurately predict seed performance in field than seed germination.

Material and Methods

In order to study effect of different planting dates on plant growth and seed yield of soybean cultivars and experiment was conducted under semi arid climatic condition in Agricultural Research Station, Bidar during 2015-16 and 2016-17. The soil type was a black clay loam, pH of 7.75 to 7.80 and the region with an annual precipitation of 847 mm. The experimental design was a factorial randomized completely block design with three replications. The experiment including eight planting dates *i.e.*, every fortnight sowing from Nov-1st fortnight up to Feb 2nd fortnight, as a first factor and two soybean cultivars (JS 335 and DSb 21) as a second factor. Crop management factors like land preparation, fertilizer, and weed control were followed as recommended for local area. All the plant protection measures were adopted to make the crop free from pest and diseases.

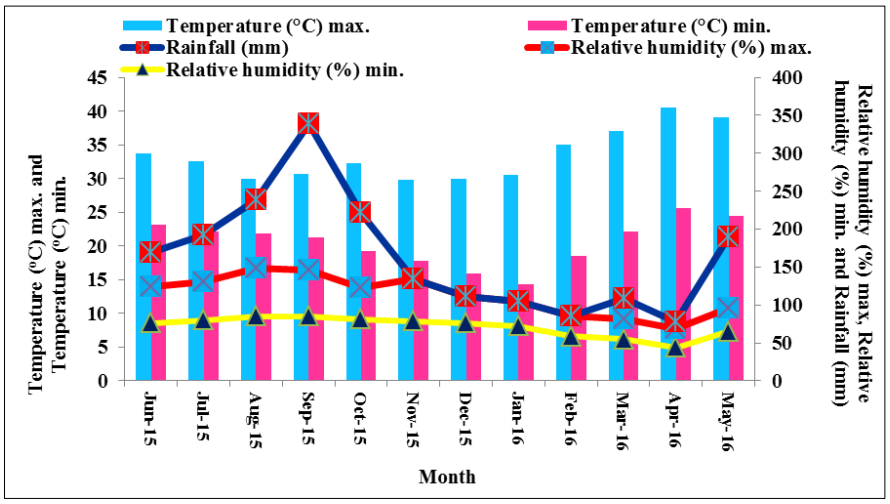

Fig 1: Mean Monthly meteorological data for the year 2015-16 at Agricultural Research Station Bidar

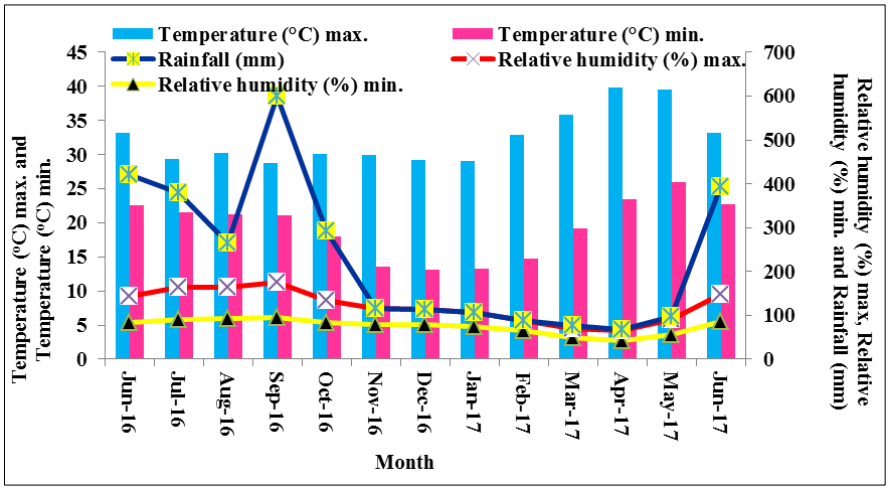

Fig 2: Mean Monthly meteorological data for the year 2016-17 at Agricultural Research Station Bidar

The crop was harvested at full maturity of all the fortnight sown crops and harvesting was done manually from each plot. Harvested crop seeds are clean and grade separately. After that seeds are carried out to seed unit laboratory, university of agricultural sciences, Raichur. The following data were collected during the experimentation.

The germination test was conducted as per ISTA (ISTA, 2013) [14] using between paper method. The number of normal seedlings counted at the end of eight day of and expressed as seed germination in percentage (%).

The speed of germination was worked out by the following formula suggested by (Maguire, 1962) [18]

Speed of germination= [G1/D1 + G2/D2 +……+ Gn/Dn]

Where, n= number of seeds germinated on day (d).

D= serial number of days

G1: Germination percentage × 100 on 1st day

Gn: Germination percentage × 100 on the nth day

The peak value of germination was taken from numbers of seeds germinated were recorded on daily basis up to the day of final count (8th day). The peak value is the cumulative germination percentage for each unit on its peak day divided by the number of days to reach that percentage. It was calculated by the formula proposed by Gairola *et al*. (2011) [9].

$$\text{Peak value of germination} = \frac{\text{Highest number of seeds germinated}}{\text{Number of days}}$$

Ten normal seedlings were selected at random on eight day of germination test and the root and shoot lengths were measured and mean was calculated and expressed in centimetres (cm) and seedling dry weight (mg). The vigour index I was calculated using the formula VI I = (Mean root length + Mean shoot length) (cm) x Germination (%) was suggested by Abdul-Baki and Anderson (1973) [1]. The vigour index II was calculated using the formula VI II = Seedling dry weight (mg) x Germination (%) and biochemical parameters like Dehydrogenase enzyme activity (OD value) was analyzed as per the method suggested by Kittock and Law (1968) [16]. α-amylase enzyme activity was analyzed as per the method suggested by Simpson and Naylar (1962) [23]. Electrical conductivity (dSm^{-1}) was conducted as per the procedure**.**

The data collected from the experiments were analyzed statistically by the procedure prescribed by Sundararaj *et al*. (1972) [26]. Whenever 'F' test was found significant, the critical difference (CD) values were calculated and treatment mean were compared at one per cent for lab experiment.

Result and Discussion

Effect of sowing dates on seed quality parameters of soybean varieties

The effect of different dates of sowing on seed quality parameters have been discussed below. The analysis of variance revealed significant differences at 1 per cent level of significance as shown in Tables 1-4.

From the results, it was revealed that, the germination percentage was significantly higher in early sowings, *i.e.,* 1st fortnight November (S_1) (91.25 %) and 2nd fortnight of November (88.54 %) compared to late (S_8) sowings February 2nd December (80.48 %).

(Table 1). There is gradual decrease in germination with delayed sowing dates. Heatherly (1996) [11] reported that germination of seeds harvested from early sowing was higher than delayed sowing.

The difference among the sowing dates revealed that the root length, shoot length and seedling length (Table 1 and 2) were found significantly higher (20.17, 21.32 and 41.49 cm, respectively) in early sowings (S_1) (November 1st fortnight) and it was followed by November 2nd fortnight (S_2) (19.15, 19.64, 38.79 cm, respectively), while (S_8) February 2nd fortnight recorded significantly lowest root length, shoot length and seedling length (15.84, 16.45 and 32.29 cm, respectively). These findings are supported by Kumar *et al*. (2011) [17] who reported that in niger seed quality parameters like germination percentage and seedling length were observed to be lower due to delayed sowing.

The seedling dry weight was found significantly higher (121.23 mg) in early sowing date (S_1) (November 1st fortnight) and it was on par with November 2nd fortnight (S_2) (117.76 mg), followed by December 1st fortnight (S_3) (111.42 mg). While, (S_8) February 2nd fortnight recorded significantly lowest seedling dry weight (99.29 mg). Higher seedling dry weight in early sowings might be due to larger seed size which could be attributed to more food reserves in the seed ultimately resulting into good seedling. Decrease in seedling dry weight in lentil seed was due to restricted supply of nutrients from mother plant to seed due to disruption of vascular connection and utilization in various physiological and metabolic processes (Khatun *et al*., 2009) [15].

The peak value of germination was found significantly higher (39.83) in early sowing date (S_1) (November 1st fortnight) and it was followed by November 2nd fortnight (S2) (37.42), while (S_8) February 2nd fortnight recorded significantly lowest peak value of germination (17.67) (Table 2). These findings are supported by Rahman *et al*. (2013) [22] who concluded that seed produced from early sowings had higher seed quality and vigour than the seed produced from delayed sowings.

The difference among the sowing dates revealed that the alpha amylase and dehydrogenase enzyme activity were (Tables 3) significantly higher (25.20 mm and 1.105, respectively) in early sowings (S_1) (November 1st fortnight) and it was followed by November 2nd fortnight (S_2) (23.72 mm and 1.040, respectively), while (S_8) February 2nd fortnight recorded significantly lowest alpha amylase and dehydrogenase activity (18.59 mm and 0.581, respectively). The electrical conductivity was found significantly lowest (0.486) in early sown crop (S_1) (November 1st fortnight) and it was followed by November 2nd fortnight (S_2) (0.556), while (S_8) February 2nd fortnight recorded significantly highest electrical conductivity (1.094) (Table 3). Low value for electrical conductivity is an indicator of high seed viability since the EC values are negatively correlated with standard germination and other seed quality traits. High electrical conductivity recorded in case of late sown crop might be attributed to higher temperature during pod development, maturity and harvesting stages which ultimately affected the seed quality.

The difference among the sowing dates revealed that the seedling vigour index - I and II were significantly (Tables 4) higher (3789 and 11065, respectively) in early sowings (S_1) (November 1st fortnight), followed by November 2nd fortnight (S_2) (3438 and 10430, respectively), while February 2nd fortnight (S_8) sowings recorded significantly lowest seedling vigour index - I and II (2600 and 7993, respectively). Higher seedling vigour index recorded in early sowings could be attributed to high root and shoot length besides good seed germination. Patil and Dighe (1985) [21] and Singh *et al*. (1987) [25] reported that the seeds obtained from early set bolls in cotton had higher seedling vigour index than the later set bolls. These findings are supported by Rahman *et al*. (2013) [22] who reported that seeds from optimum time of sowing had higher vigour index because of high seed quality.

Table 1: Effect of sowing dates on germination (%), root length (cm) and shoot length (cm) in soybean cultivars JS 335 and DSb 21

	Germination (%)			Root length (cm)			Shoot length (cm)		
	2015-16	2016-17	Pooled mean	2015-16	2016-17	Pooled mean	2015-16	2016-17	Pooled mean
V1	85.41 (58.08)	87.80 (59.48)	86.60 (58.77)	18.73	19.28	19.00	18.91	19.45	19.18

V2	83.01 (56.79)	84.19 (57.42)	83.60 (58.77)	16.22	16.63	16.43	17.94	18.63	18.28
S.Em±	0.27	0.31	0.29	0.1	0.11	0.1	0.12	0.12	0.12
CD@1%	1.05	1.21	1.11	0.39	0.42	0.39	0.45	0.47	0.46
S1	90.63 (61.08)	91.87 (62.03)	91.25 (61.53)	19.96	20.38	20.17	21.05	21.58	21.32
S2	87.83 (59.39)	89.26 (60.32)	88.54 (59.84)	18.98	19.31	19.15	19.28	20.01	19.64
S3	85.02 (57.81)	87.08 (58.97)	86.05 (58.38)	18.04	18.13	18.09	18.76	19.62	19.19
S4	84.32 (57.43)	86.21 (58.49)	85.27 (57.95)	17.78	17.88	17.83	18.57	19.69	19.13
S5	83.23 (56.85)	85.42 (58.04)	84.33 (57.44)	17.26	17.56	17.41	18.27	18.8	18.53
S6	82.00 (56.21)	84.65 (57.62)	83.33 (56.90)	16.31	17.21	16.76	18.06	18.28	18.17
S7	80.73 (55.57)	82.39 (56.42)	81.56 (55.99)	15.91	17.01	16.46	17.27	17.57	17.42
S8	79.90 (55.16)	81.07 (55.74)	80.48 (55.44)	15.53	16.15	15.84	16.15	16.75	16.45
S.Em±	0.66	0.76	0.7	0.25	0.26	0.25	0.28	0.29	0.12
CD@1%	2.57	2.96	2.72	0.96	1.02	0.96	1.11	1.14	0.46
V1S1	91.57 (61.70)	93.25 (63.00)	92.41 (62.32)	21.24	21.98	21.61	22.03	22.66	22.35
V1S2	89.00 (60.05)	91.41 (61.65)	90.20 (60.82)	20.08	20.65	20.36	20.15	20.46	20.3
V1S3	86.16 (58.43)	89.15 (60.14)	87.66 (59.27)	19.58	19.68	19.63	19.26	20.15	19.7
V1S4	85.33 (57.97)	88.29 (59.66)	86.81 (58.80)	19.18	19.28	19.23	19.03	19.96	19.5
V1S5	84.40 (57.47)	87.37 (59.12)	85.88 (58.28)	18.58	18.85	18.71	18.5	19.07	18.78
V1S6	83.00 (56.72)	86.36 (58.54)	84.68 (57.62)	17.75	18.35	18.05	18.35	18.5	18.42
V1S7	82.46 (56.44)	84.32 (57.42)	83.39 (56.93)	17.05	18.15	17.6	17.77	17.89	17.83
V1S8	81.33 (55.88)	82.21 (56.31)	81.77 (56.09)	16.38	17.28	16.83	16.2	16.91	16.55
V2S1	89.69 (60.46)	90.50 (61.06)	90.10 (62.32)	18.68	18.78	18.73	20.07	20.51	20.29
V2S2	86.66 (58.73)	87.10 (58.98)	86.88 (60.82)	17.88	17.98	17.93	18.4	19.56	18.98
V2S3	83.89 (57.19)	85.00 (57.79)	84.44 (59.27)	16.51	16.58	16.54	18.27	19.1	18.68
V2S4	83.31 (56.89)	84.13 (57.32)	83.72 (58.80)	16.38	16.48	16.43	18.1	19.42	18.76
V2S5	82.07 (56.24)	83.47 (56.97)	82.77 (58.28)	15.95	16.28	16.11	18.03	18.52	18.28
V2S6	81.00 (55.69)	82.94 (56.69)	81.97 (57.62)	14.88	16.08	15.48	17.77	18.07	17.92
V2S7	79.00 (54.70)	80.46 (55.42)	79.73(56.93)	14.78	15.88	15.33	16.77	17.25	17.01
V2S8	78.46 (54.43)	79.93 (55.16)	79.20 (56.09)	14.68	15.01	14.85	16.1	16.58	16.34
S.Em±	0.94	1.08	0.99	0.35	0.37	0.35	0.4	0.42	0.41
CD@1%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of sowing dates on seedling length (cm), seedling dry weight (mg) and peak value of germination in soybean cultivars JS 335 and DSb 21

	Seedling length (cm)			**Seedling dry weight (mg)**			**Peak value of germination**		
	2015-16	**2016-17**	**Pooled mean**	**2015-16**	**2016-17**	**Pooled mean**	**2015-16**	**2016-17**	**Pooled mean**
V1	37.64	38.72	38.18	109.38	111.08	110.23	29.58	30.92	30.25
V2	34.15	35.26	34.71	106.07	108.1	107.08	27.31	28.46	27.89
S.Em±	0.21	0.22	0.22	0.69	0.59	0.59	0.19	0.2	0.19
CD@1%	0.83	0.86	0.84	2.7	2.31	2.29	0.73	0.76	0.74
S1	41.01	41.96	41.49	120.05	122.41	121.23	39.08	40.58	39.83
S2	38.26	39.32	38.79	116.25	119.27	117.76	36.75	38.08	37.42
S3	36.81	37.75	37.28	109.64	113.2	111.42	32.42	33.42	32.92
S4	36.35	37.57	36.96	107.78	109.74	108.76	29.58	31.25	30.42
S5	35.53	36.36	35.94	104.64	106.42	105.53	28	28.92	28.46
S6	34.37	35.5	34.93	103.23	104.11	103.67	24.58	27.25	25.92
S7	33.18	34.59	33.88	100.96	102.2	101.58	19.75	20.08	19.92
S8	31.68	32.89	32.29	99.22	99.37	99.29	17.42	17.92	17.67
S.Em±	0.52	0.54	0.53	1.7	1.46	1.44	0.46	0.48	0.47
CD@1%	2.02	2.1	2.05	6.61	5.65	5.61	1.78	1.86	1.82
V1S1	43.27	44.64	43.96	121.33	123.79	122.56	39.67	41.33	40.5
V1S2	40.23	41.1	40.67	118.61	120.25	119.43	37.83	39.5	38.67
V1S3	38.84	39.83	39.33	111.88	115.31	113.59	34.33	35	34.67
V1S4	38.21	39.24	38.73	109.64	112.39	111.01	31.33	32.83	32.08
V1S5	37.08	37.91	37.5	106.07	108.67	107.37	29.5	30.17	29.83
V1S6	36.1	36.84	36.47	105.64	105.33	105.49	25.83	28.67	27.25
V1S7	34.82	36.04	35.43	101.67	102.52	102.1	20.17	21.5	20.83
V1S8	32.58	34.19	33.38	100.17	100.35	100.26	18	18.33	18.17
V2S1	38.75	39.29	39.02	118.77	121.03	119.9	38.5	39.83	39.17
V2S2	36.28	37.54	36.91	113.89	118.28	116.09	35.67	36.67	36.17
V2S3	34.77	35.68	35.23	107.41	111.09	109.25	30.5	31.83	31.17
V2S4	34.48	35.9	35.19	105.92	107.1	106.51	27.83	29.67	28.75
V2S5	33.98	34.8	34.39	103.2	104.18	103.69	26.5	27.67	27.08
V2S6	32.65	34.15	33.4	100.81	102.89	101.85	23.33	25.83	24.58
V2S7	31.55	33.13	32.34	100.25	101.87	101.06	19.33	18.67	19
V2S8	30.78	31.6	31.19	98.27	98.38	98.33	16.83	17.5	17.17
S.Em±	0.74	0.77	0.75	2.41	2.06	2.04	0.65	0.68	0.66
CD@1%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of sowing dates on biochemical activities in soybean cultivars JS 335 and DSb 21

	Alpha amylase activity (mm)			Dehydrogenase activity (OD value)			Electrical conductivity (dSm-1)		
	2015-16	2016-17	Pooled mean	2015-16	2016-17	Pooled mean	2015-16	2016-17	Pooled mean
V1	21.54	22.96	22.25	0.926	0.953	0.94	0.77	0.75	0.76
V2	20.3	22.26	21.28	0.816	0.842	0.829	0.79	0.78	0.78
S.Em±	0.13	0.14	0.14	0.006	0.006	0.006	0.005	0.005	0.005
CD@1%	0.51	0.56	0.54	0.022	0.025	0.023	0.019	0.019	0.019
S1	24.22	26.18	25.2	1.093	1.118	1.105	0.497	0.476	0.486
S2	22.67	24.76	23.72	1.028	1.052	1.04	0.568	0.563	0.556
S3	21.85	24.25	23.05	0.935	0.985	0.96	0.643	0.633	0.638
S4	20.88	23.38	22.13	0.896	0.919	0.907	0.703	0.685	0.694
S5	20.3	22.09	21.2	0.861	0.867	0.864	0.765	0.748	0.756
S6	20.07	21.04	20.55	0.829	0.853	0.841	0.899	0.886	0.892
S7	19.25	20.12	19.68	0.757	0.795	0.776	1.057	1.035	1.046
S8	18.12	19.06	18.59	0.571	0.592	0.581	1.104	1.085	1.094
S.Em±	0.32	0.35	0.34	0.014	0.016	0.014	0.012	0.012	0.012
CD@1%	1.26	1.36	1.31	0.053	0.06	0.056	0.047	0.047	0.047
V1S1	25.07	26.73	25.9	1.154	1.195	1.175	0.474	0.439	0.456
V1S2	23.4	25.07	24.23	1.088	1.126	1.107	0.559	0.554	0.557
V1S3	22.57	24.57	23.57	1.009	1.013	1.011	0.64	0.622	0.631
V1S4	21.3	23.63	22.47	0.954	0.983	0.969	0.692	0.676	0.684
V1S5	21.1	22.27	21.68	0.918	0.915	0.917	0.76	0.742	0.751
V1S6	20.7	21.67	21.18	0.897	0.909	0.903	0.897	0.877	0.887
V1S7	19.53	20.4	19.96	0.795	0.867	0.831	1.025	1.024	1.025
V1S8	18.67	19.31	18.99	0.591	0.617	0.604	1.091	1.07	1.081
V2S1	23.37	25.62	24.49	1.031	1.04	1.036	0.519	0.513	0.516
V2S2	21.93	24.46	23.2	0.968	0.977	0.973	0.577	0.571	0.574
V2S3	21.13	23.93	22.53	0.86	0.958	0.909	0.646	0.644	0.645
V2S4	20.47	23.13	21.8	0.837	0.854	0.846	0.714	0.694	0.704
V2S5	19.5	21.92	20.71	0.803	0.818	0.811	0.769	0.753	0.761
V2S6	19.43	20.41	19.92	0.762	0.797	0.779	0.9	0.896	0.898
V2S7	18.97	19.83	19.4	0.719	0.723	0.721	1.088	1.046	1.067
V2S8	17.57	18.81	18.19	0.55	0.567	0.558	1.116	1.099	1.108
S.Em±	0.46	0.5	0.48	0.019	0.022	0.02	0.017	0.017	0.017
CD@1%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Effect of sowing dates on seedling vigour index in soybean cultivars JS 335 and DSb 21

	Seedling vigour index-I			Seedling vigour index-II		
	2015-16	2016-17	Pooled mean	2015-16	2016-17	Pooled mean
V1	3225	3410	3317	9364	9778	9571
V2	2844	2976	2910	8828	9125	8976
S.Em±	19.95	20.98	20.46	59.53	61.88	60.71
CD@1%	77.42	81.4	79.41	231.03	240.14	235.58
S1	3719	3859	3789	10881	11248	11065
S2	3362	3513	3438	10213	10647	10430
S3	3132	3292	3212	9325	9861	9593
S4	3066	3242	3154	9090	9467	9278
S5	2959	3108	3034	8711	9095	8903
S6	2820	3007	2914	8467	8815	8641
S7	2682	2852	2767	8152	8420	8286
S8	2532	2668	2600	7929	8057	7993
S.Em±	48.87	51.38	50.12	145.83	151.58	148.7
CD@1%	189.63	199.39	194.5	565.91	588.23	577.06
V1S1	3962	4163	4062	11110	11543	11327
V1S2	3580	3757	3669	10556	10992	10774
V1S3	3346	3551	3449	9640	10280	9960
V1S4	3260	3464	3362	9356	9923	9639
V1S5	3130	3312	3221	8952	9494	9223
V1S6	2996	3182	3089	8768	9096	8932
V1S7	2871	3039	2955	8384	8644	8514
V1S8	2650	2811	2730	8147	8250	8198
V2S1	3475	3556	3516	10652	10953	10803
V2S2	3144	3270	3207	9870	10302	10086
V2S3	2917	3033	2975	9011	9443	9227
V2S4	2873	3020	2946	8824	9010	8917
V2S5	2789	2905	2847	8470	8696	8583
V2S6	2645	2832	2739	8166	8534	8350

V2S7	2492	2666	2579	7920	8196	8058
V2S8	2415	2526	2470	7710	7864	7787
S.Em±	69.11	72.66	70.88	206.23	214.37	210.29
CD@1%	NS	NS	NS	NS	NS	NS

Effect of varieties on quality parameters

The highest germination percentage, root length, shoot length, seedling length, seedling dry weight, peak value of germination, seedling vigour index-I and seedling vigour index-II were recorded in JS 335 (86.60 %, 19.00 cm, 19.18 cm, 38.18 cm, 110.23 mg, 30.25, 3317 and 9571, respectively) followed by DSb 21 (83.60 %, 16.43 cm, 18.28 cm, 34.71 cm, 107.08 mg, 27.89, 2910 and 8976, respectively) in both the seasons. Among the cultivars, biochemical parameters of seeds were significantly higher in JS 335 (22.25 mm and 0.940 OD value, respectively) followed by DSb 21 (21.28 mm and 0.829 OD value, respectively) during both years of study and electrical conductivity values were significantly higher in JS 335 (0.759 dSm^{-1}) followed by DSb 21 (0.784 dSm^{-1}) during both years of study. These findings are in conformity with Uem and Unioeste (2003) [28] who reported that the seeds from the optimum sowing dates had higher percentage of germination than early or delayed planting crop because of more favourable climatic conditions during seed development. Kumar *et al*. (2011) [17] who reported that in niger seed quality parameters like germination percentage and seedling length were found to be lower when the sowing was delayed Partha *et al*. (2016) [20] who reported that soybean seedling dry weight decreased in seeds from late sown crop and similar results were observed by Ishrath *et al*. (2017) [13] in soybean.

The varieties also showed a significant difference in seedling vigour index-I

and II. Variety JS 335 (3317 and 9571, respectively) showed significantly highest seedling vigour index - I and II as compared to DSb 21 (2910 and 8976, respectively). Singh *et al*. (1978) [24] observed that in soybean germination and seedling vigour index was negatively correlated with 100 seed weight, seed volume, thickness and weight of seed coat, indicating that germination and vigour decreased in large and those with hard seeds.

Conclusion

Among the eight sowing dates, November 1st fortnight sowing resulted in highest seed quality in both soybean cultivars JS 335 and DSb 21.

References

1. Abdul-Baki AA, Anderson JD. Vigour determination in soybean by multiple criteria. Crop Science. 1973; 13:630-633.
2. Anonymous. The Soybean Processors Association of India, 2017. http://www.sopa.org.
3. Ashton D, Atkins B, Chirco E, Everson L, Guerke W, Jackson B *et al*. Seedling Evaluation Handbook (eds.): Contribution No. 35 to the Handbook on Seed Testing. Association of Official Seed Analysts. Ithica, NY, 2007.
4. Bradley CA, Harman GL, Wax LM, Pedersen WL. Quality of harvested seed associated with soybean cultivars and herbicides under weed-free conditions. Plant Disease. 2002; 86:1036-1042.
5. Calvino PA, Sadras VO, Andrade FH. Quantification of environmental and management effects on the yield of late-sown soybean. Field Crops Res. 2003; 83:67-77.
6. Egli DB, TeKrony DM, Heitholt JJ, Rupe J. Air temperature during seed filling and soybean seed fermentation and vigour. Crop Science. 2005; 45:1329-1335.
7. Fischer WR, Berfelel R, Schafer R, Schopfer P. Accumulation of storage material, precocious germination and development of desiccation tolerance during seed maturation in mustard (*Sinapis alba* L.). Botanica Acta. 1988; 101:344-354.
8. Gairola KC, Nautiyal AR, Dwivedi AK. Effect of temperatures and germination media on seed germination of *Jatropha curcas*. Advances in bioresearch. 2011; 2(2):66-71.
9. Galau GA, Jakobsen KS, Hughes DW. The control of late dicot embryogenesis and early germination. Physiologia Plantarum. 1991; 81:280-288.
10. Hasan MA, Ahmad JU, Hossain T, Mian MAK, Haque MM. Evaluation of the physiological quality of wheat seed as influenced by high parent plant growth temperature. Journal of Crop Science and Biotechnology. 2013; 16:69-74.
11. Heatherly LG. Yield and germinability of seed from irrigated and non-irrigated early and late planted soybean. Crop Science. 1996; 36(4):1000-1006.
12. Heydecker W. Vigour. Pages. 209-252 in E.N. Robers, ed. Viability of seeds. Chapman and Hall, London, UK, 1972.
13. Ishrath S, Sujatha P, Jhansi Rani K, Sudha Rani M, Keshavulu K. Physiological quality of soybean (*Glycine max* L.) as affected by sowing date. Journal of Pharmacognosy and Phytochemistry. 2017; 6(5):1246-1249.
14. ISTA. International Rules for Seed Testing, Seed Science and Technology. 2013; 27:25-30.
15. Khatun A, Kabir G, Bhuiyan MAH. Effect of harvesting stages on the seed quality of lentil (*Lens culinaris* L.) during storage. Bangladesh Journal of Agriculture Research. 2009; 34(4):565-576.
16. Kittock DL, Law AG. Relationship of seedling vigour to respiration and tetrazolium chloride reduction by germinating wheat seeds. Agronomy Journal. 1968; 60:286-288.
17. Kumar BNM, Basave Gowda, Vyakarnahal BS, Deshpande VK, Kenchanagoudar PV. Influence of sowing dates on production of seed yield in Niger. Karnataka Journal of Agriculture Science. 2011; 24(3):289-293.
18. Maguire JD. Speed of germination-aid in selection and evaluation for seedling emergence and vigour, Crop Science. 1962; 2:176-177.
19. Mc Donald MB, Phaneendranath BR. A modified accelerated aging seed vigour test for soybean. Journal of Seed Technology. 1978; 3:27-37.
20. Partha KK. Tuhin SR. Shahjalal HK, Khursheda P, Khairul Mazed HEM. Effect of sowing date on yield and seed quality of soybean. Journal of Agriculture and Ecology Research. 2016; 9(4):1-7.
21. Patil VG, Dighe. Cotton seed quality related to time of harvest and position of bolls. Cotton Development Board,

1985; 14(4):29-32.
22. Rahman MM, Rahman MM, Hussain MM. Effect of sowing date on germination and vigour of soybean seeds. The Agriculturists. 2013; 11(1):67-75.
23. Simpson GM, Naylar JM. Dormancy studies in seeds of *Avena fatuva* and relationship between maltase, amylases and gibberellins. Canada Journal of Botany. 1962; 40:1959-1673.
24. Singh CB, Mishra PK, Mehata SK. Notes on the correlation between some seed characteristics and germination per cent in soybean. Indian Journal of Agriculture Science. 1978; 48:121.
25. Singh IP, Singh DP, Chabra BS. Seed germination in relation to time of pickings in cotton. Cotton Development Board. 1987; 17(2):37-38.
26. Sundararaj N, Nagaraju S, Venkata Ramu MN, Jagannath MR. Design and Analysis of Experiments, UAS, Bangalore, 1972, 148-155.
27. TeKrony DM, Egli DB. Relationship between laboratory indices of soybean seed vigour and field emergence. Crop Science. 1977; 17:573-577.
28. Uem, Unioeste. Sowing seasons and quality of soybean seeds. Scientia Agricola. 2003; 60:245-252.
29. Welbaun GE, Tissaoui T, Bradford KJ. Water relations of seed development and germination in muskmelon (*cucumis melo* L.). Sensitivity of germination to water potential and abscisic acid. Plant Physiology. 1990; 92:1092-1937.