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Effect of Planting Windows for Seed Production of Soybean (*Glycine max* L.) in off Season under Kaylan Karnataka Region

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Authors' contributions

This work was carried out in collaboration among all authors. Author KL designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors Basavegowda and MR managed the analyses of the study. Authors Siddaram, PDS, BM and GCS have managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To identify the best planting time for obtaining higher seed yield and quality of Soybean in off season.
Study Design: Randomized completely block design (RCBD)
Place and Duration of Study: Agricultural Research Station, Halladkere, Bidar, Karnataka between 2016 and 2017.
Methodology: A field experiment was conducted at Agricultural Research Station, Halladkere, Bidar to find out the best off season planting time for quality seed production of Soybean. The certified seeds of soybean varieties, JS-335 and Dsb-21 were sown with recommended package of practices at appropriate field condition from November to February at every fortnight with a spacing of 30 cm X 10 cm. The quality parameters related to seed were carried out in the laboratory of seed science department. Further, soybean seeds were treated with fungicide (carbendazim 25% + mancozeb 75%) at the rate of 3 gram per kg of seeds.

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Results: From the present investigation, it was observed that among the different sowing dates, soybean varieties (JS 335 and DSb 21) sown during 1st fortnight of November recorded significantly higher plant growth parameters as well as seed yield followed by 2nd fortnight of November during off season. Further, climatic factors like rainfall, maximum and minimum temperature and relative humidity played a major role in the off season to produce higher seed yield and quality of Soybean.
Conclusion: Among various sowing dates, November 1st Fortnight sowing resulted in highest seed yield with better seed quality in both cultivars (JS-335 and Dsb-21) of soybean.

Keywords: Soybean; planting windows; season; climatic factors; seed quality.

1. INTRODUCTION

Soybean [*Glycine max* (L.) Merill] has become a miracle crop of the twentieth century. It is a triple beneficiary crop, a unique food, a valuable feed and an industrial raw material. It is one of the most important protein (40%) and oil (20%) source for both human and animal consumption besides occupying third place in oil seed production in the world. Globally, it is grown in an area of 120 million hectares with a production of 351 million tonnes and productivity of 2920 kg per hectare. Though it is comparatively new crop to India, it occupies an area of 11.40 million hectares with a production of 12 million tonnes and productivity of 1010 kg per hectare. 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 hectares [1]. The major soybean growing districts in Karnataka are Bidar, Dharwad, Belgaum, Bagalkot and Haveri.

One of the major problems encountered in soybean seed production in India is lack of availability of good quality seeds at the time of planting, as many of the seed lots lose their viability quickly due to presence of thin seed coat coupled with embryo in the periphery. Further, the seed is also subjected to various injuries during post harvest operations like threshing, seed grading and handling during seed storage. Sowing of soybean cultivars with high yield potential at optimum planting time is considered as hopeful approach to increase soybean production. Proper management of soybean by identifying a suitable or altering the planting date is an excellent approach to increase both crop yield and economic benefit. The previous studies showed that the early or late planting shows significantly reduction in crop yield [2]. Effects of planting dates on soybean yiels and other traits varied at locations [3].

As reported in the literature, out of the various cultural factors influencing the productivity of soybean, the sowing date was found to be more important. Hence, determination of optimum date of sowing for different varieties is considered as an important pre requisite for the successful cultivation of this crop, but practically sufficient data on optimum date of sowing are not available in Karnataka state and it is necessary to evaluate the performance of different cultivars of soybean under different sowing dates.. Environmental conditions associated with the sowing affect crop features related to the capture of radiation and partitioning of crop resources. In spring sown soybean crop, yield is most susceptible to nutritional and water deficits during late flowering and grain filling [4]. Delay in sowing generally shifts reproductive growth into less favourable condition with shorter days and lower radiation and temperature [5].

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 and environment interaction to identify the varieties which are stable in different environments [6]. The previous studies showed that the early or late planting significantly reduces the crop yield [7,8,9]. Sowing date is variable with the largest effect on crop yield [6]. Because of heavy rains during harvesting, many seed lots are failing to meet the requisite germination standards. This leads to severe shortage of quality seed especially breeder and foundation class seeds. In such situations, contingency seed production especially in the off season is very much essential and hence there is a need to identify the best planting time for enhanced quality seed production during off season. In view of this, an experiment was conducted to study the “Effect of planting windows for quality seed production of Soybean (*Glycine max L.*) in off season.”

2. MATERIALS AND METHODS

2.1 Experimental Details

A field experiment was conducted at Agricultural Research Station, Halladkere, Bidar, Karnataka to find out the best off season planting time for quality seed production of Soybean. The certified seeds of soybean varieties, JS-335 and Dsb-21 were sown with recommended package of practices at appropriate field condition from November to February at every fortnight with a spacing of 30 cm X 10 cm. The design used to conduct the experiment was randomized complete block design (RCBD).

2.2 Weather Data during Cropping Period

Bidar district receives well distributed rainfall from both South-West and North-East monsoons. The normal annual rainfall of Bidar district is 884 mm of which major rainfall is received in two peaks (March - April months & August - September months). The maximum and minimum temperature ranges from 38.5°C in the month of May to 13.7°C in the month of January, respectively. The maximum and minimum relative humidity of 85 per cent in the month of August-September and 32 percent in the month of May, respectively. During the experiment period, total annual rainfall received (710 mm) was below the normal during 2015 and above (1311 mm) the normal during 2016. The maximum and minimum temperatures were 40.5°C in the month of April and 13°C in the month of December, respectively which were above the normal during the year 2016. Maximum and Minimum relative humidity was 96 per cent in the month of September and 25 per cent in the month of April, 2016 respectively. The details of weather parameters recorded during experimental period at Agricultural Research Station, Halladkere, Bidar is presented in Table 1.

Table 1. Monthly meteorological data of Agricultural Research Station, Halladkere, Bidar for the experimental period (2015 to 2017)

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
Jan-2015	27.2	13.7	65	42	19.2
Feb-15	31.8	15.2	68	25	0.0
Mar-15	32.7	19.3	64	35	105.9
April-15	34.7	21.8	68	36	89.0
May-15	38.5	24.9	61	32	8.2
June-15	33.7	23.1	76	48	44.7
July-15	32.6	22.2	80	51	61.4
Aug-15	29.9	21.8	85	64	89.7
Sept-15	30.7	21.2	85	61	193.1
Oct-15	32.2	19.2	81	42	98.8
Nov-15	29.8	17.8	79	55	0.0
Dec-15	29.9	15.9	76	35	0.0
Jan-2016	30.5	14.3	72	33	0.0
Feb-16	35.0	18.5	59	26	0.0
Mar-16	37.1	22.1	55	26	28.1
April-16	40.5	25.6	44	25	9.3
May-16	39.1	24.5	65	31	93.4
June-16	33.2	22.3	84	60	277.5
July-16	29.3	21.5	91	73	215.3
Aug-16	30.2	21.3	92	71	102.7
Sep-16	28.7	21.1	96	79	426.1
Oct-16	30.1	18.0	83	51	158.8
Nov-16	29.9	13.5	80	36	0.0
Dec-16	29.2	13.1	78	36	0.0
Jan-2017	29.1	13.2	75	32	0.0
Feb-17	32.9	14.7	66	23	0.0
Total	**-**	**-**	**-**	**-**	**2021.2**

Table 2. Effect of sowing dates on growth and yield parameters of soybean cultivars (JS- 335 and DSb -21)

Treatments	Plant height (cm) at 90 DAS			Days to 50 % flowering			Days to maturity		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
V1	53.86	55.65	54.75	37	38	38	83.12	84.23	83.68
V2	51.87	53.42	52.64	38	39	39	87.97	88.54	88.26
S.Em±	**0.33**	**0.34**	**0.32**	**0.12**	**0.11**	**0.11**	**0.43**	**0.46**	**0.39**
CD@1%	**0.94**	**0.99**	**0.94**	**0.35**	**0.32**	**0.30**	**1.25**	**1.33**	**1.12**
S1	55.78	57.44	56.61	39	41	40	89.95	90.45	90.20
S2	54.62	56.28	55.45	38	40	39	89.36	89.70	89.53
S3	54.07	55.74	54.91	38	40	39	86.34	87.62	87.08
S4	53.20	55.02	54.11	38	39	38	85.02	86.11	85.57
S5	52.68	54.70	53.69	37	39	38	84.42	85.18	84.80
S6	51.82	53.48	52.65	37	39	37	84.25	85.05	84.65
S7	50.83	52.50	51.66	36	38	37	83.28	84.20	83.74
S8	49.92	51.09	50.51	36	37	36	81.56	82.79	82.17
S.Em±	**0.80**	**0.84**	**0.80**	**0.29**	**0.27**	**0.26**	**1.06**	**1.13**	**0.95**
CD@1%	**2.30**	**2.42**	**2.30**	**0.85**	**0.78**	**0.74**	**3.06**	**3.26**	**2.74**
V1S1	56.50	58.17	57.33	39	40	39	87.45	88.45	87.95
V1S2	55.77	57.43	56.60	38	39	38	87.19	87.19	87.19
V1S3	55.34	57.01	56.18	37	39	38	83.27	84.70	83.99
V1S4	54.26	56.23	55.25	37	39	38	82.53	83.94	83.24
V1S5	54.22	56.60	55.42	37	39	37	82.10	83.20	82.65
V1S6	52.81	54.47	53.64	37	38	37	82.05	82.97	82.51
V1S7	51.76	53.43	52.59	36	37	36	81.06	82.39	81.73
V1S8	50.17	51.83	51.00	35	36	36	79.33	81.00	80.17
V2S1	55.05	56.72	55.88	41	41	41	92.44	92.44	92.44
V2S2	53.47	55.13	54.30	39	40	40	91.54	92.20	91.87
V2S3	52.80	54.47	53.63	39	40	39	89.81	90.55	90.18
V2S4	52.13	53.80	52.97	38	39	38	87.51	88.28	87.90
V2S5	51.13	52.80	51.97	37	39	38	86.73	87.15	86.94
V2S6	50.83	52.49	51.66	37	38	38	86.44	87.12	86.78
V2S7	49.90	51.57	50.73	36	38	37	85.51	86.01	85.76
V2S8	49.68	50.35	50.01	36	37	36	83.78	84.58	84.18
S.Em+	**1.13**	**1.18**	**1.13**	**0.41**	**0.38**	**0.36**	**1.50**	**1.59**	**1.34**
CD@1%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3. Effect of sowing dates on growth and yield parameters of soybean cultivars (JS- 335 and DSb -21)

Treatments	Number of seeds per pod			Number of pods per plant			100 seed weight(g)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
V1	2.52	2.75	2.64	19.13	20.44	19.78	9.23	10.65	9.94
V2	2.46	2.69	2.57	18.37	19.88	19.13	8.50	10.12	9.31
S.Em±	**0.02**	**0.02**	**0.02**	**0.15**	**0.13**	**0.13**	**0.06**	**0.11**	**0.07**
CD@1%	**0.05**	**0.05**	**0.05**	**0.43**	**0.38**	**0.38**	**0.16**	**0.32**	**0.21**
S1	2.74	2.97	2.86	20.95	21.76	21.36	9.70	11.72	10.71
S2	2.62	2.84	2.73	19.85	20.81	20.35	9.26	10.92	10.09
S3	2.55	2.78	2.67	19.13	20.67	19.90	9.12	10.61	9.87
S4	2.52	2.75	2.64	18.85	20.52	19.68	8.81	10.32	9.57
S5	2.44	2.67	2.56	18.56	20.22	19.39	8.74	10.16	9.45
S6	2.41	2.64	2.53	18.20	19.83	19.02	8.63	10.05	9.34
S7	2.35	2.58	2.46	17.59	19.05	18.32	8.40	9.80	9.10
S8	2.30	2.53	2.41	16.85	18.42	17.63	8.23	9.50	8.87
S.Em±	**0.04**	**0.04**	**0.02**	**0.37**	**0.32**	**0.13**	**0.14**	**0.27**	**0.18**
CD@1%	**0.11**	**0.12**	**0.05**	**1.05**	**0.93**	**0.38**	**0.39**	**0.79**	**0.51**
V1S1	2.81	3.04	2.93	21.58	22.12	21.85	9.93	11.94	10.93
V1S2	2.63	2.85	2.75	20.50	20.95	20.73	9.54	11.07	10.30
V1S3	2.58	2.81	2.70	19.40	20.80	20.10	9.58	10.80	10.19
V1S4	2.57	2.80	2.69	19.10	20.77	19.93	9.33	10.69	10.01
V1S5	2.47	2.70	2.59	18.64	20.31	19.48	9.29	10.47	9.88
V1S6	2.42	2.65	2.54	18.33	19.93	19.13	9.10	10.35	9.73
V1S7	2.37	2.60	2.49	18.03	19.70	18.87	8.66	10.18	9.42
V1S8	2.33	2.56	2.45	17.42	18.90	18.16	8.39	9.72	9.06
V2S1	2.67	2.90	2.79	20.32	21.40	20.86	9.47	11.50	10.49
V2S2	2.60	2.83	2.72	19.20	20.67	19.93	8.98	10.77	9.88
V2S3	2.52	2.75	2.64	18.87	20.53	19.70	8.65	10.43	9.54
V2S4	2.47	2.70	2.59	18.60	20.27	19.43	8.29	9.96	9.12
V2S5	2.41	2.64	2.53	18.47	20.13	19.30	8.20	9.86	9.03
V2S6	2.40	2.63	2.52	18.07	19.73	18.90	8.16	9.74	8.95
V2S7	2.32	2.55	2.44	17.15	18.40	17.77	8.14	9.42	8.78
V2S8	2.26	2.49	2.38	16.28	17.94	17.11	8.07	9.28	8.68
S.Em+	**0.06**	**0.06**	**0.06**	**0.52**	**0.46**	**0.45**	**0.14**	**0.39**	**0.25**
CD@1%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 4. Effect of sowing dates on growth and yield parameters of soybean cultivars (JS- 335 and DSb -21)

Treatments	Seed yield per plant(g)			Seed yield per plot(kg)			Seed yield (kg)/ha		
	2015-16	2016-17	Pooled mean	2015-16	2016-17	Pooled mean	2015-16	2016-17	Pooled mean
V1	8.84	10.26	9.55	2.20	2.45	2.33	1468	1635	1552
V2	8.40	9.89	9.14	1.95	2.20	2.08	1303	1469	1386
S.Em±	**0.06**	**0.06**	**0.06**	**0.01**	**0.04**	**0.01**	**9.20**	**10.24**	**9.72**
CD@1%	**0.16**	**0.19**	**0.17**	**1.05**	**0.06**	**0.04**	**26.58**	**29.58**	**28.08**
S1	10.80	11.74	11.27	2.81	3.06	2.94	1873	2040	1957
S2	9.30	10.75	10.03	2.56	2.81	2.69	1707	1874	1791
S3	8.80	10.43	9.62	2.33	2.58	2.46	1554	1721	1637
S4	8.50	10.13	9.32	2.18	2.43	2.31	1455	1622	1538
S5	8.43	9.97	9.20	2.03	2.28	2.15	1351	1518	1434
S6	8.15	9.68	8.91	1.87	2.12	2.00	1247	1413	1330
S7	7.65	9.27	8.46	1.60	1.85	1.73	1068	1234	1151
S8	7.33	8.60	7.96	1.24	1.49	1.37	829	995	912
S.Em±	**0.14**	**0.16**	**0.15**	**0.03**	**0.04**	**0.03**	**22.54**	**25.09**	**23.81**
CD@1%	**0.39**	**0.46**	**0.43**	**0.10**	**0.12**	**0.10**	**65.11**	**72.46**	**68.78**
V1S1	11.19	12.11	11.65	2.88	3.13	3.01	1923	2090	2006
V1S2	9.63	11.03	10.33	2.69	2.94	2.82	1795	1962	1879
V1S3	9.00	10.67	9.83	2.45	2.70	2.58	1634	1801	1718
V1S4	8.47	10.13	9.30	2.33	2.58	2.45	1553	1720	1637
V1S5	8.39	9.91	9.15	2.15	2.40	2.28	1435	1601	1518
V1S6	8.23	9.67	8.95	2.03	2.28	2.15	1351	1518	1434
V1S7	8.07	9.73	8.90	1.75	2.00	1.87	1166	1332	1249
V1S8	7.72	8.80	8.26	1.35	1.58	1.46	889	1056	973
V2S1	10.41	11.38	10.89	2.74	2.74	2.86	1824	1990	1907
V2S2	8.97	10.47	9.72	2.43	2.43	2.55	1619	1786	1703
V2S3	8.60	10.20	9.40	2.21	2.21	2.34	1474	1640	1557
V2S4	8.53	10.13	9.33	2.04	2.04	2.16	1357	1523	1440
V2S5	8.47	10.03	9.25	1.90	1.90	2.03	1268	1434	1351
V2S6	8.07	9.68	8.88	1.71	1.71	1.84	1142	1309	1226
V2S7	7.23	8.80	8.02	1.45	1.45	1.58	970	1137	1053
V2S8	6.93	8.40	7.67	1.15	1.15	1.28	768	934	851
S.Em+	**0.14**	**0.19**	**0.21**	**0.05**	**0.05**	**0.05**	**31.88**	**35.48**	**33.68**
CD@1%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

3. RESULTS AND DISCUSSION

Soybean seed is a poor storer, hence loses its viability very quickly and many pathogens during storage reduce the seed quality. So, maintenance of seed quality during storage assumes paramount importance.

Different planting dates do have a significant influence on the yield, agronomic and morphological characters of soybean and interaction among planting date, cultivar are significant for seed yield and yield components. The phenotypic data in the current study represented the combined effect of genotypic and environmental factors influences yield and yield components. The effects of planting date were apparent especially for pod yield, number of pods per plant, seed yield per plant and test weight. These characters were significantly decreased with harvest of late planting in both the cultivars, since pod maturity and harvest time were influenced by cold weather, rain and frost in late planting. Previous studies revealed that each 15 days delay in planting date affected the yield. This research showed that early planting produced greater yields compared to late planting, since pod filling and harvest time were less affected by cold weather, rain and frost. In addition, late planting date has a higher probability of experiencing water stress during the critical pod filling phase resulting in lower yields even under cold, rainy conditions.

JS-335 cultivar has recorded higher plant height (57 cm) at 90 DAS as compared to Dsb-21 (53 cm). This differences in growth characters may be attributed to their inherent characteristics. These findings are in close agreement with the findings of Rajput and Yadav [10] in pigeonpea, Billore et al. [11] in soybean.

The varieties showed significant differences for days to maturity. The variety, JS-335 required minimum days for maturity (84 days) over Dsb-21 (88 days). Park et al. [12] observed that the average number of days from field emergence to maturity was 124, 123, 134 and 118 days for *cv. Hwangkeamkong, Jangyeokong, Danyeopkong* and *Williams*, respectively. A significant difference for leaf spot (%) incidence was observed during both the years of experiment where, Dsb-21showed significantly less leaf spot incidence (2.09%) compared to JS-335 (2.54%).

3.1 Effect of Sowing Dates on Growth and Yield Parameters of Soybean

Growth characters of the plant depend on initiation of tissues, organ primordial differentiation and expand of cells besides several metabolic activities are associated with this phenomenon. The important environment factors which affect the soybean production are amount and distribution of rainfall over crop period, temperature and sunlight *etc*. The evaporation from soil and transpiration through foliage also play important role in soybean. The significant differences in soybean were noticed with respect to plant height, days to 50 per cent flowering and days to maturity (Table 2). Among different dates of sowing, the crop sown during 1st fortnight of November produced significantly higher growth characters followed by second fortnight of November (Tables 2,3).

The differential behaviour in dates of sowing with respect to growth characters could be explained solely by the variation in climatic conditions. The results are in close conformity with the findings of Kane et al. [13] who reported that the growth stages depend strongly on sowing dates in soybean. Ahmed et al. [14] observed that the plant height, days to 50 per cent flowering and days to maturity were significantly affected by sowing dates in soybean. Further, Batwal et al. [15] observed that the growth characters were influenced by the sowing date in soybean. The plant height of soybean was significantly increased in soybean from early sowing as reported by Patil et al. [16].

Significant differences were noticed for the yield attributing characters of soybean due to different sowing dates (Table 4).The data indicated that early sowing *i.e*., 1st fortnight of November produced significantly higher number of pods per plant (21.4) and number of seeds per pod (2.9) as compared to 2nd fortnight of February sowing date where in number of pods per plant (17.6) and number of seeds per pod (2.4) reduced significantly. Similar results were reported by Sambasiva Reddy [17], Mugnisjah and Nakamura [18] and Mridula et al. [19] as number of pods per plant was significantly affected by sowing dates. Kolak [20] reported that mean pod number per plant increased from early sowing to late sowing in soybean. Yield can be considered to be the final expression of the physiological and metabolic activities of plants and is governed by various factors. These yield attributing characters

have direct effect on plant productivity because of number of pods per plant, number of seeds per pod, 100 seed weight was significantly affected by sowing date on soybean.

4. CONCLUSION

The two years data indicated that, the growth and yield parameters of Soybean were significantly affected by planting dates and varieties except interaction, where these parameters were declined when planting was delayed. Maximum growth and yield parameters were observed in the early sown crop as compared to late sown crop. Most of the seed yield and yield contributing parameters including quality parameters were maximum from the seeds which are obtained from early sown crop (1st Fortnight of November). Among the eight sowing dates, November 1st Fortnight sowing resulted in highest seed yield with better seed quality in both cultivars (JS-335 and Dsb-21) of soybean.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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