OptimumSowing time and Suitable Cultivars for Seed Quality Parameters ofSoybean (*Glycine max* L.) during Off-Season in Northern Telangana Zone

ABSTRACT

Aims: To identify the optimum sowing time and suitable varieties of soybeanfor quality of soybean during the off-season in the Northern Telangana Agroclimatic zone of Telangana state in India.
Study design: Strip plot design with three replications.
Place and Duration of Study: The Regional Sugarcane and Rice Research Station, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rudrur,Nizamabad District, Telangana state, India, between October 2022 and June 2023.
Methodology: The field experiment was conducted in medium clay loam soil under irrigated condition. The experiment was laid out in strip plot design with three varieties *viz.,*JS 335 (V_1), ASB 22 (V_2) and KDS 726 (V_3) as horizontal strips and nine dates of sowings(16 days interval)*viz.,* 3 Oct (D_1), 19 Oct (D_2), 3 Nov (D_3), 19 Nov (D_4), 3 Dec (D_5) 19 Dec (D_6), 3 Jan (D_7), 19 Jan (D_8) and 3 Feb (D_9) as vertical strips, replicated thrice.The seeds were sown by dibbling at 5 cm apart within the row and rows were space at 45 cm apart. Standard recommended package of practice of *kharif* season suggested by PJTSAU was followed. The data on seed quality parameters were recorded by placing 100 seeds of 3 replications in paper towels and field.
Results:.The results of the experiment revealed that,the seeds of *cv.* JS 335 and *cv.* KDS 726 collected from D_2recorded the highest values of germination%, seed vigour index-I and seed vigour index-II which was tested at 1 week after harvest, 1 month after harvest and in June month. Whereas, the seeds of *cv.* ASB 22 in D_1 maintained higher germination%, seed vigour index-I and seed vigour index-II across the time interval of testing from 1 week after harvest to June month. The field emergence test in June month results showed that, the seeds of *cv.* JS 335, ASB 22 and KDS 726 produced with 3 Jan, 3 Nov and 19 Nov sowings, respectively recorded highest number of seed emergence at 3rd, 4th, 7th and 14th day of count.
Conclusion: The soybean *cv.* ASB 22 sown in the first week of Oct was found to be suitable for producing high quality seeds during the off season.

key words: Soybean, off season, , Dates of sowing, germination percentage,seed vigour index, field emergence.

1. INTRODUCTION

Soybean is recognized as the “Golden bean” of the 21st century. The demand for soybean is raising globally due to its inimitable composition, outstanding dietetic value and health benefits (Khan *et al.,* 2020). It occupied a prominent position among the legumes that supplement nearly one-third of the world population. India is the 5th largest soybean producer after Brazil (34.45 %), U.S.A. (29.01 %), Argentina (16.56 %), and China (4.00 %). In India, soybean produced over an area of 121.5 lakh hectares with a production of 129.9 lakh tonnes and productivity of 1069 kg ha^{-1} (Indiastat, 2021). The major soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka and Telangana. In Telangana, soybean produced over an area of 1.55 lakh hectares with a production of 2.68 lakh tonnesand productivity of 1731 kg ha^{-1} (Indiastat, 2021). Though the soybean crop has immense opportunity in global market, yields are extremely lower than its potential yield in Telangana. In Telangana, the soybean crop is cultivated during *kharif* season. The main factors that reduce yields are climate unevenness, inappropriate growing time, lower germination percentage, meager quality and scarcity of high quality seed(). Further the

viability and longevity of soybean seeds are very low. Therefore there isless opportunity to store the seeds produced during *kharif* for the next *kharif*season(). It is inevitable to import the seed from distance places like north India every season which is much expensive for the farmers of Telangana. If the crop produced during *rabi* or *summer* (off season), the seeds can be used for next *kharif* so that, the additional cost incurred on cold storage and transport can be minimized (). No documented results are available on soybean cultivation during the off-season for either grain or seed purposes. The suitable planting date of soybean is probably the most conspicuous cultural practice for obtaining quality seedduring the off-season(). 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 interactions to identify the varieties which are stable in different environments (Calvino*et al*., 2003). Heydecker (1972) outlined a number of distinct determinants that influence seed vigour and viability. These include genetic factors, preharvest 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 (Galau *et al.*, 1991, Welbaun*et al.*, 1990 and Bergf*et al*., 1988). When parental plants are exposed to high temperatures during growth and development, the quality of the seed is highly influenced (Hasan *et al*., 2013). Soybean cultivars also respond differently to environmental stress, such as temperature during the growing season, resulting in differences in seed vigour (Bradley *et al.,* 2002). Keeping in view of the poor germination, shortage of seed availability in soybean, arising opportunity for alternate crops to *rabi* rice, increase in irrigation potential, and variable climatic conditions in Telangana, the present investigation is prioritized to identify the optimum time of sowing and suitable cultivars for seed quality parameters of soybean during the off-season in Northern Telanagana zone.

2. MATERIALS AND METHODS

A field experiment was conducted during off-season2022-23 at Regional Sugarcane & Rice Research Station, Rudrur, Nizamabad. Which is geographically located at $18^{o}.56^{"}$ N latitude and $77^{o}.87^{"}$ E longitude, at an altitude of 404 m above the mean sea level situated in Northern climatic zone of Telangana. The soil of experimental field was clay loam in texture, low in available nitrogen (120 kg ha^{-1}) and organic carbon content (0.38%), and high in available phosphorus (42.08 kg ha^{-1}) and potassium (285.2 kg ha^{-1}). The experiment was laid out in strip plot design with twenty seven treatments, comprising of three varieties *viz.,* JS 335 (V_1), ASB 22 (V_2) and KDS 726 (V_3) as horizontal strips and nine dates of sowings *viz.,* 3 Oct (D_1), 19 Oct (D_2), 3 Nov (D_3), 19 Nov (D_4), 3 Dec (D_5) 19 Dec (D_6), 3 Jan (D_7), 19 Jan (D_8) and 3 Feb (D_9) as vertical strips, replicated thrice.A seed rate of 75 kg $ha^{-1}$was used for sowing. The spacing adopted was 45 cm ×5 cm sown at a depth of 3-4 cm. Seeds were treated with Carbendazim @ 1 g kg^{-1} of seed to protect crop against seed borne diseases. Recommended dose of 60-60-40 (N - P_2O_5 - K_2O) kg ha^{-1} was applied to soybean crop, in the form of urea, single super phosphateand muriate of potash, respectively to all the plots. Total quantity of phosphorous and potassium was applied as basal whereas nitrogen was applied in two equal splits, one at the time of sowing and another at 30 days after sowing. The crop was irrigated at an interval of 7 to 10 days depends up on visual moisture stress symptoms exhibited by the crop canopy.Standard recommended package of practice of *kharif* season suggested by PJTSAU was followed. The seed quality parameters viz., germination percentage, seed vigour index-I and seed vigour index –II were calculated by using the following formulae.

Germination (%)

Germination test was conducted as per (ISTA, 2015) using between paper method, the number of normal seedlings were counted on 5^{th} day by using the following formula.

$$\text{Germination \%} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds placed}} \times 100$$

Seedling length (cm)

Ten seedlings from each treatment were separated from paper towel and length of these seedlings was measured using metric scale after removal of cotyledons, followed by taking the mean length of ten seedlings, it is expressed in centimeter (ISTA, 2015).

Seedling dry matter (mg)

The ten seedlings used for taking seedling length were further kept for drying in hot air oven maintained at a temperature of 85 ± 1°C for 24 hours. Dry weight of ten seedlings was recorded and expressed as mean seedling dry matter in milligrams (ISTA, 2015).

Seed vigour index-I and seed vigour index-II

Seed vigour index-I and seed vigour index-II were calculated as per the formula given by Abdul-Baki and Anderson (1973) and expressed in whole number.

SVI-I = Germination (%) × Seedling length (cm)

SVI-II = Germination (%) × Seedling dry matter (mg)

Field emergence (%)

Field emergence was calculated by placing 100 seeds of 3 replications in field and the number of seeds germinated and seedlings emerged in the field on 3rd day, 4th day, 7th day and 14th day after sowing were taken as field emergence (%).

The field emergence (%) was calculated by using the following formula suggested by Saha and Basu (1981).

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings emerged}}{\text{Total number of seeds sown}} \times 100$$

This test was conducted at 1 week after harvest, 1 month after harvest and finally in June month using the seeds collected from 3 October to 3 January sowings in JS 335 and ASB 22 whereas in KDS 726 it was tested for seeds collected from 3 October to 19 December sowing dates. In rest of the sowing dates the seeds were not set hence, field emergence test could not be conducted.

3. RESULTS AND DISCUSSIONS

3.1 Germination%

The germination percentage recorded at 1 week after harvest, 1 month after harvest and in June month with the seeds of different date sown crops was depicted in Fig. 1. The results indicated that, the *cv.* JS 335 and *cv.* ASB 22 were maintained at more than 97% germination across the time interval of lab test. Whereas, the seeds of *cv.* KDS 726 collected from different dates sowings done with an interval of 15 days from 3 Oct to 3 Dec maintained more than 94% germination across the interval of lab test. However, the seeds of 19 Dec planting, maintained 89% to 91% germination in lab test conducted at 1 week after harvest, 1 month after harvest and in June month.The higher percentage of germination (99% to 100%) in

seeds of *cv.* JS 335 and *cv.* ASB 22 collected from D_1 to D_6 dates sown crops might have favored by RH-I and RH-II prevailed during grain filling phase of the crop. Further, the reduced germination (97%) in seeds of 3 Jan (D_7) sown crop tested in lab during June month was due to the higher temperatures and evaporation prevailed during the grain filling phase of *cv.* JS 335. The higher percentage of germination (94% to 100%) in seeds of *cv.* KDS 726 collected from D_1 to D_6 dates sown crops might have been favored by RH-II prevailed during grain filling phase of the crop. Further, the reduced germination (89% to 91%) in seeds of 19 Dec (D_6) sown crop tested in lab from 1 week after harvest to June month could be due to negative effect of the rainfall, rainy days and evaporation prevailed during the grain filling phase.The influence of dates of sowing on germination% of different soybean cultivars was also reported by Navya *et al*. (2022).

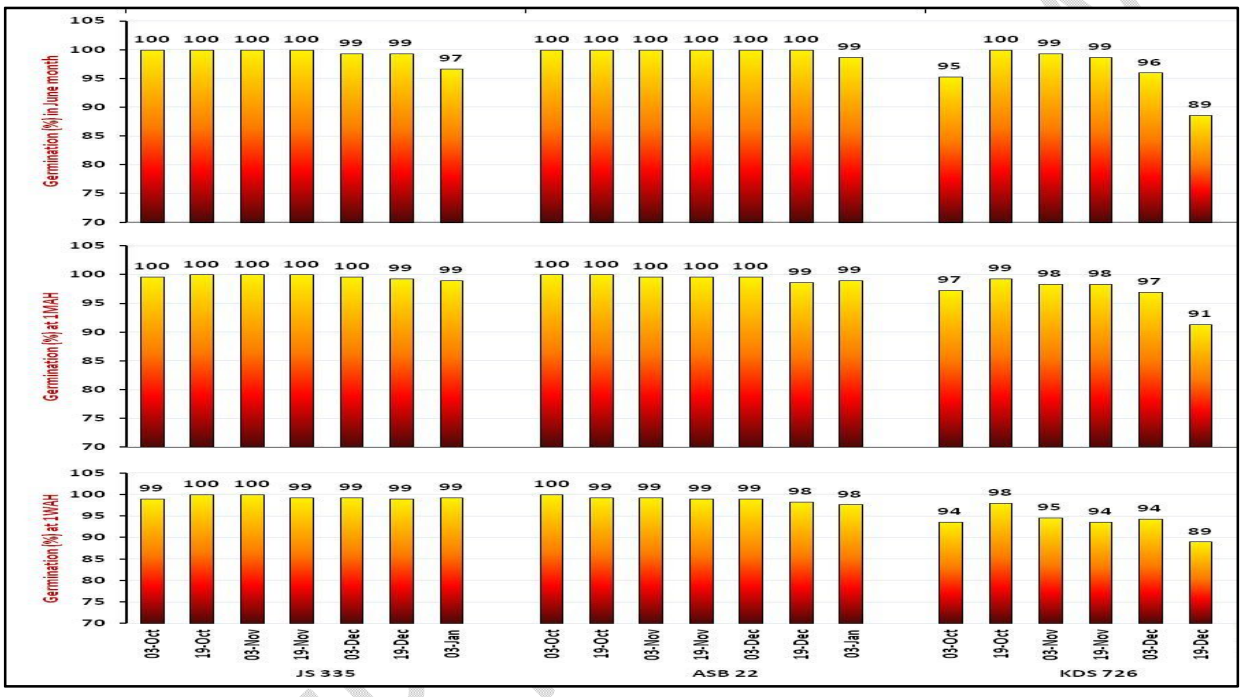


Fig. 1. Seed germination (%) of soybean cultivars grown under different dates of sowing tested at 1 week after harvest (1WAH), 1 month after harvest (1MAH) and in June month

3.2 Seedling length (cm) and seedling drymatter (mg seedling^{-1})

The seedling length and seedling drymatter measured during germination test conducted at 1 week after harvest, 1 month after harvest and in June month with the seeds of different dates sown soybean cultivars was depicted in Fig.2 and Fig.3. The resultsindicated that, the highest seedling length and seedling drymatter of the *cv.* JS 335 were recorded with the seeds collected from 19 Oct sowing tested at 1 week after harvest, 1 month after harvest and in June month. However, the seedling length and seedling drymatter of this cultivar steadily decreased with the seeds of 3 Nov to 3 Jan sowings across the dates of testing in lab. The similar trend was also observed with the *cv.* KDS 726. On the other hand, the maximum seedling length and seedling drymatter across the time interval of testing was recorded with the seeds of *cv.* ASB 22 collected from 3 Oct sown crop and was decreased linearly with the seeds collected from 19 Oct to 3 Jan sowings. The seedling length and seedling drymatter during germination process depends on the size of the seeds and the reserved food material available for germination. The food material accumulation in seed is depends upon translocation of food material from source to sink. The source and sink relationship is largely governed by the weather conditions prevailed during grain filling stage. The bold seeds of October sown crop have given lengthier and heaviest seedlingsin germination test. As the sowing

delays from November to January the seed filling and seed size were reduced gradually in all the cultivars and exhibited decreased seedling length and seedling drymatter during germination test conducted at different intervals. These results are in line with the findings of Navya*et al*. (2022).

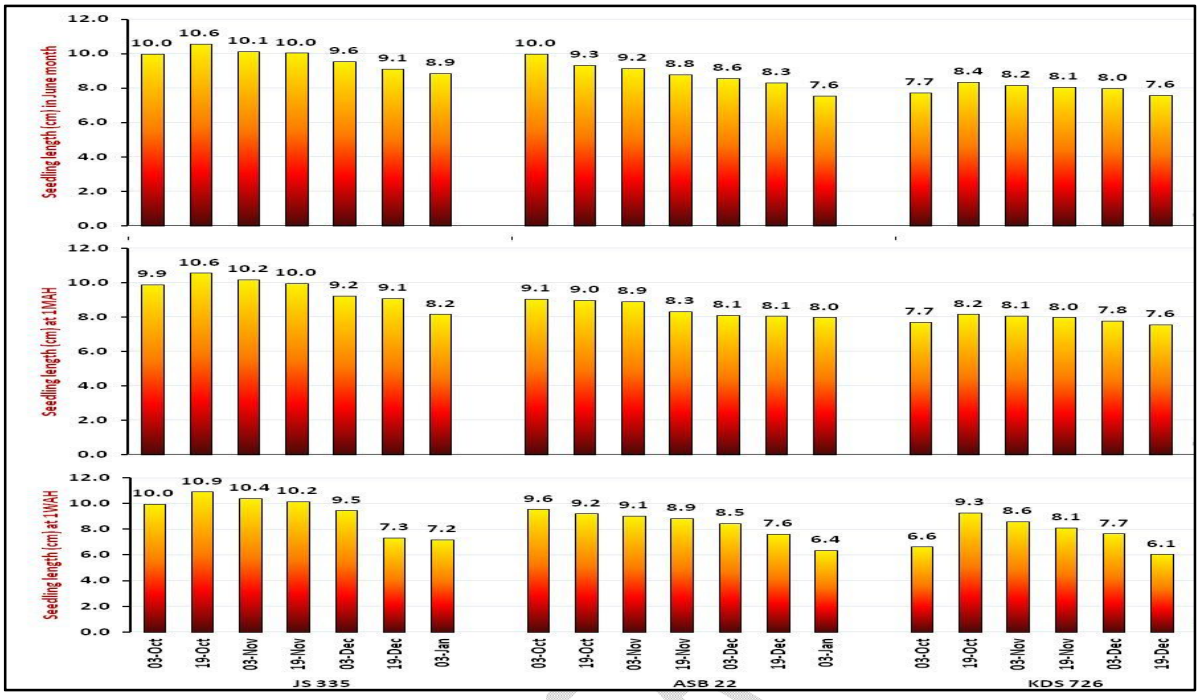


Fig. 2. Seedling length of soybean cultivars grown under different dates of sowing measured at 1 week after harvest (1WAH), 1 month after harvest (1MAH) and in June month

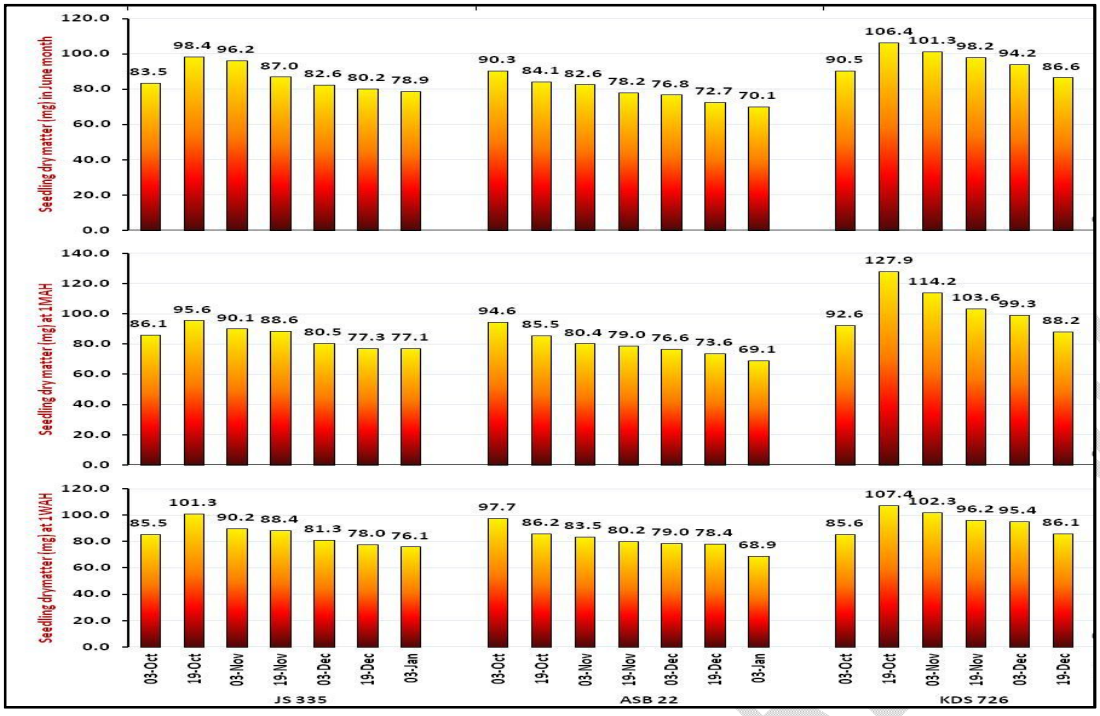


Fig. 3. Seedling dry matter of soybean cultivars grown under different dates of sowing measured at 1 week after harvest (1WAH), 1 month after harvest (1MAH) and in June month

3.3Seed vigour index –I and seed vigour index –II

The seed vigour index-I and seed vigour index-II tested at 1 week after harvest, 1 month after harvest and in June month with the seeds of different dates sown soybean cultivars was depicted in Fig. 4 and Fig.5.The results showed that, the highest seed vigour index-I and seed vigour index-II of the *cv.* JS 335 were recorded with the seeds collected from 19 Oct sowing tested at 1 week after harvest, 1 month after harvest() and in June month(). However, the seed vigour index-I and seed vigour index-II of this cultivar steadily decreased with the seeds of 3 Nov to 3 Jan sowings across the dates of testing from … to …. The similar trend was also observed with the cv. KDS 726. On the other hand, the maximum seed vigour index-I and seed vigour index-II across the time interval of testing was recorded with the seeds of *cv.* ASB 22 collected from 3 Oct sown crop and was decreased linearly with the seeds collected from 19 Oct to 3 Jan sowings from … to…... The highest seed vigour index-I and seed vigour index-II in seeds of *cv.* JS 335 (V_1), ASB 22 (V_2) and KDS 726 (V_3) collected from 19 Oct (V_1D_2), 3 Oct (V_2D_1) and 19 Oct (V_3D_2) date sown crops, respectively could have been favored by relative humidity prevailed during grain filling phase of the crop. Further, the rise in temperatures and evaporation during the grain filling phase could have negative effect on quality of seed in terms of seed vigour index-I and seed vigour index-II in all the cultivars (). The influence of dates of sowing on seed vigour index-I and seed vigour index-II of different soybean cultivars was also reported by Navya *et al*. (2022).

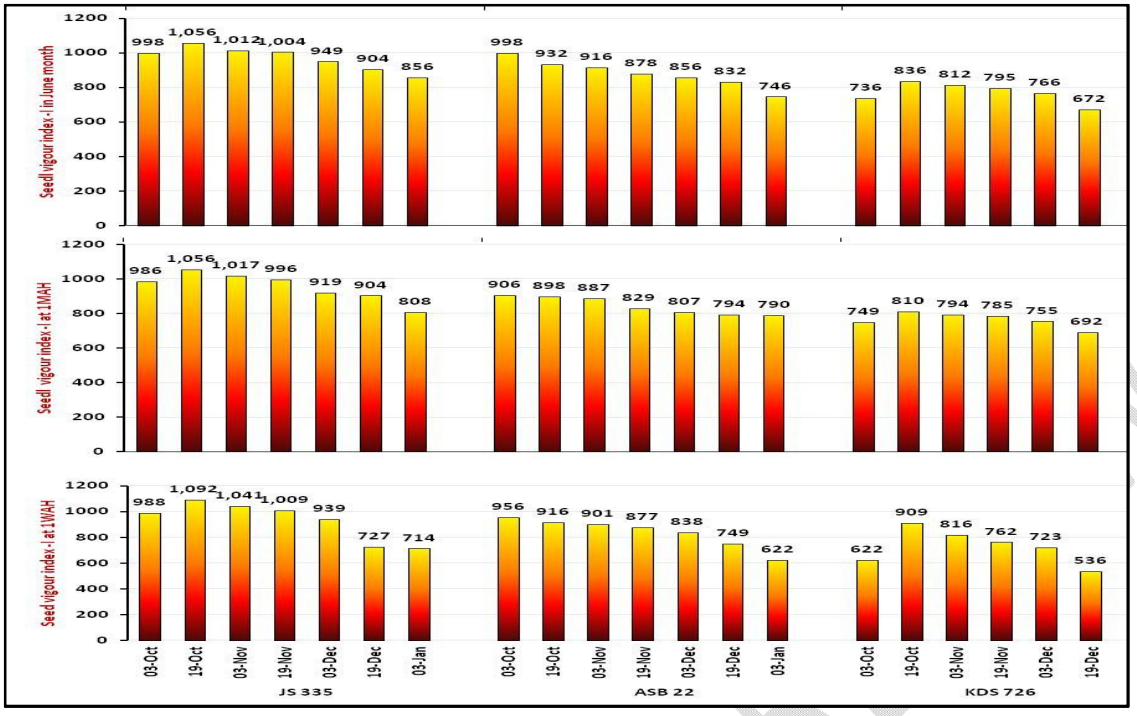


Fig. 4. Seed vigour index - I of soybean cultivars grown under different dates of sowing tested at 1 week after harvest (1WAH), 1 month after harvest (1MAH) and in June month

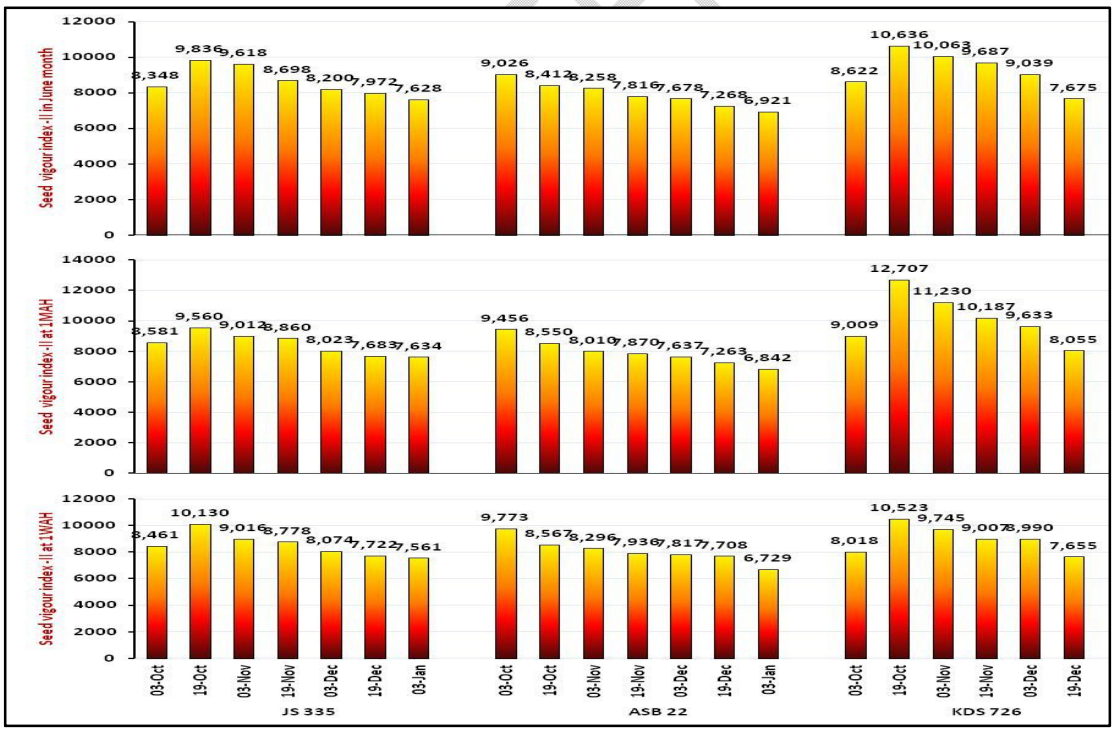
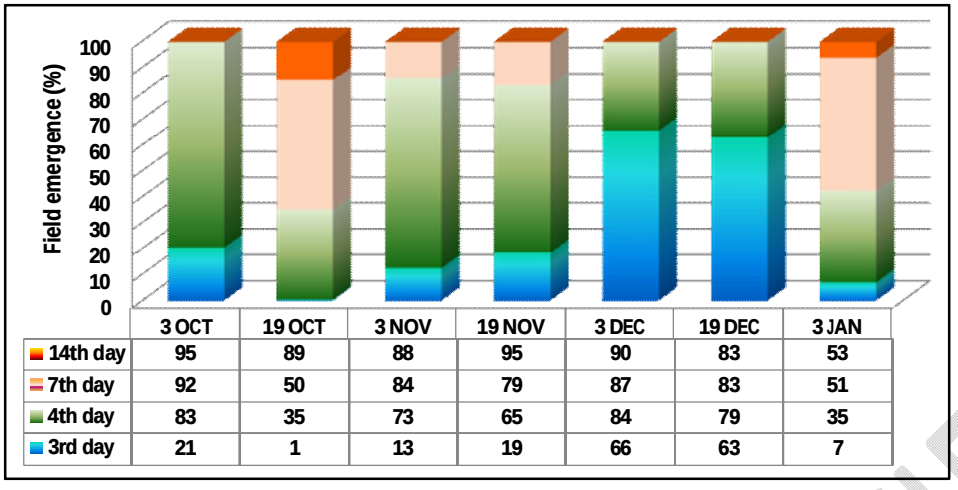


Fig. 5. Seed vigour index – II of soybean cultivars grown under different dates of sowing tested at 1 week after harvest (1WAH), 1 month after harvest (1MAH) and in June month

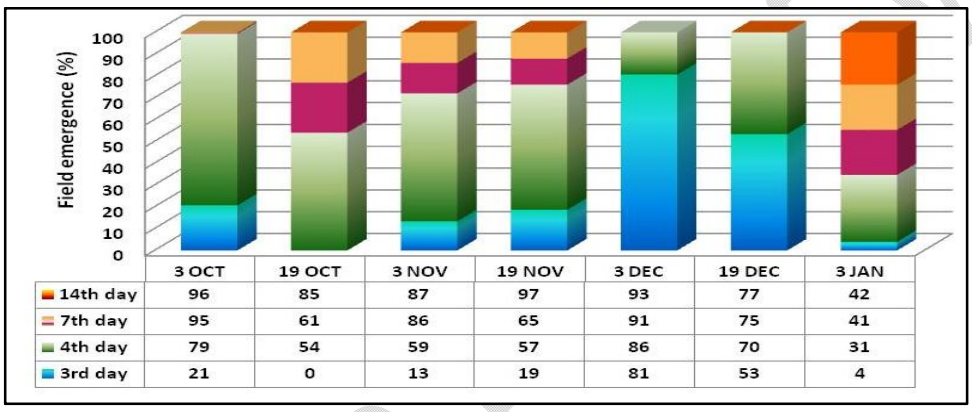
3.4 Field emergence test

The cultivar field emergence test was conducted at 1 week after harvest, 1 month after harvest and in June month with seeds of soybean cultivars grown under different dates of sowing. The data on percentage of seeds germinated at 3rd day, 4th day, 7th day and 14th day were collected, summarized and results were discussed hereunder. The result of field emergence test conducted at 1 week after harvest of *cv.* JS 335, ASB 22 and KDS 726 were presented in Fig. 6, 7 and 8, respectively. The results indicated that, the seeds of *cv.* JS 335 and ASB 22 collected from 3 Dec sown crop exhibited higher germination percentage at 3rd day (66% and 81%), 4th day (84% and 86%), 7th day (87% and 91%) and 14th day (90% and 93%) of observation as compared to its preceding and succeeding dates sown crops. Further, the seeds of 3 Jan sown crop of these varieties were found very poor in terms of percentage of seed emergence at 3rd day (7% and 4%), 4th day (35% and 31%), 7th day (51% and 41%) and 14th day (53% and 42%) of observation. Whereas, the maximum percentage of emergence at 3rd day (71%), 4th day (82%), 7th day (89%) and 14th day (89%) of *cv.* KDS 726 was observed in 19 Nov sowing as compared to its preceding and succeeding date sown crops. The seeds of this cultivar pertaining to 19 Dec sowing were found to be very poor in percentage of emergence 3rd day (2%), 4th day (21%), 7th day (27%) and 14th day (27%) of observation.The result of field emergence test conducted at 1 month after harvest of *cv.* JS 335, ASB 22 and KDS 726 were presented in Fig. 9, 10 and 11, respectively. The results shows that, the seeds of *cv.* JS 335 and ASB 22 collected from 19 Nov and 3 Nov sown crops, respectively exhibited highest germination percentage at 3rd day (57% and 53%), 4th day (73% and 90%), 7th day (85% and 94%) and 14th day (81% and 96%) of observation as compared to its preceding and succeeding dates sown crops. Further, the seeds of 3 Jan sown crop were found very poor in terms of percentage of seed emergence at 3rd day (7% and 16%), 4th day (35% and 45%), 7th day (48% and 59%) and 14th day (48% and 59%) of observation. On the other hand, the maximum percentage of emergence at 3rd day (45%), 4th day (70%), 7th day (73%) and 14th day (73%) of *cv.* KDS 726 was observed in 19 Nov sowing as compared to its preceding and succeeding dates sown crops. The seeds of this cultivar collected from 19 Dec sowing were found to be very poor in percentage of emergence at 3rd day (5%), 4th day (29%), 7th day (39%) and 14th day (40%) of observation.The result of field emergence test conducted in June month of *cv.* JS 335, ASB 22 and KDS 726 were presented in Fig. 12, 13 and 14, respectively. The results shows that, the seeds collected from 3 Jan and 3 Nov sown crops of *cv.* JS 335 and ASB 22, respectively exhibited highest germination percentage at 3rd day (50% and 48%), 4th day (92% and 95%), 7th day (95% and 99%) and 14th day (95% and 99%) of observation as compared to remaining sowing dates. Further, the seeds of 19 Dec sown crop of *cv.* JS 335 and 3 Dec sown crop of *cv.* ASB 22 were found very poor in terms of percentage of seed emergence at 3rd day (35% and 35%), 4th day (77% and 76%), 7th day (86% and 85%) and 14th day (87% and 86%) of observation. Whereas, the *cv.* KDS 726 recorded the maximum percentage of emergence at 3rd day (46%), 4th day (85%), 7th day (92%) and 14th day (93%) in 19 Nov sowing as compared to its preceding and succeeding date sown crops. The seeds of this cultivar from 19 Dec sown crop was found to be very poor in percentage of emergence at 3rd day (29%), 4th day (63%), 7th day (76%) and 14th day (77%) of observation.From the above results, it can be inferred that, there is a clear variations in retaining vigour and viability of the seeds among the soybean cultivars under investigation. The seeds of *cv.* ASB 22 andKDS 726 produced with 3 Nov and 19 Nov sowings, respectively retained their vigour, viability and maintained high germination percentage upto June month of field emergence test. Whereas, the seeds of the *cv.* JS 335 produced from 19 Nov sowing lost its speed of emergence, vigour and viability in the month of June field emergence test. Further, the seeds harvested from 3 Jan sowing of this cultivar could be able to maintain high germination percentage in June month test. The inherent genetic properties of cultivars and prevailing weather conditions during grain filling phase were found to be key drivers of seed viability in soybean cultivars (). The influence of dates of sowing on field emergence of different soybean cultivars was also reported by Navya *et al*. (2022).



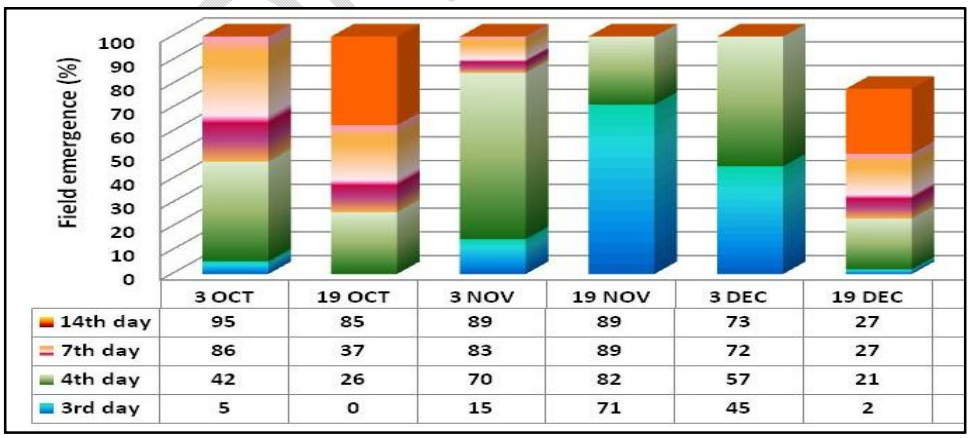
	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC	3 JAN
14th day	95	89	88	95	90	83	53
7th day	92	50	84	79	87	83	51
4th day	83	35	73	65	84	79	35
3rd day	21	1	13	19	66	63	7

Fig. 6. Field emergence (%) tested at 1 week after harvest of JS 335 grown under different dates of sowing



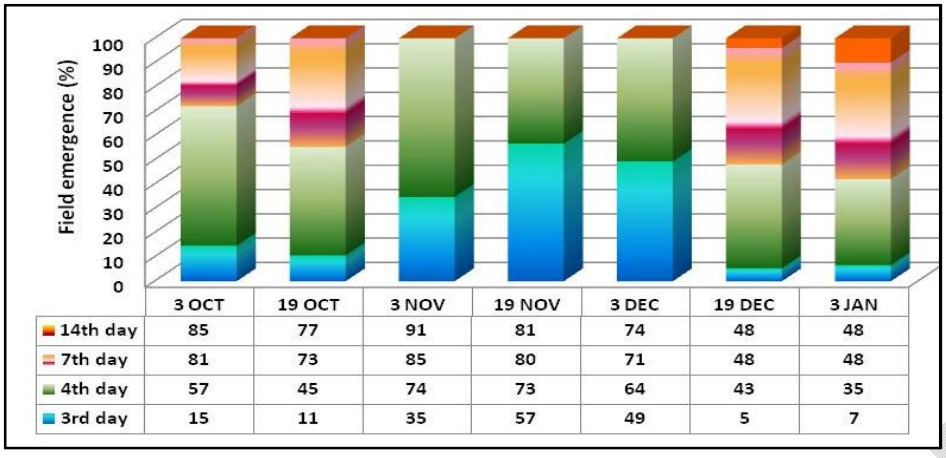
	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC	3 JAN
14th day	96	85	87	97	93	77	42
7th day	95	61	86	65	91	75	41
4th day	79	54	59	57	86	70	31
3rd day	21	0	13	19	81	53	4

Fig. 7. Field emergence (%) tested at 1 week after harvest of ASB 22 grown under different dates of sowing



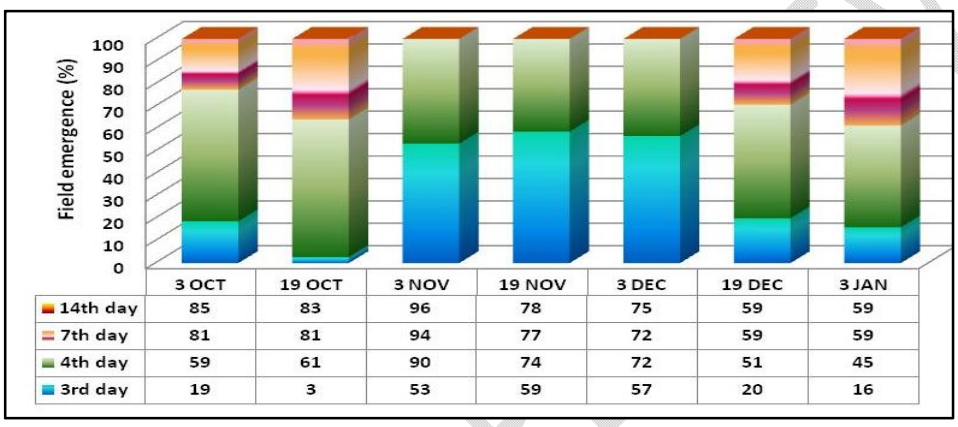
	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC
14th day	95	85	89	89	73	27
7th day	86	37	83	89	72	27
4th day	42	26	70	82	57	21
3rd day	5	0	15	71	45	2

Fig. 8. Field emergence (%) tested at 1 week after harvest of KDS 726 grown under different dates of sowing



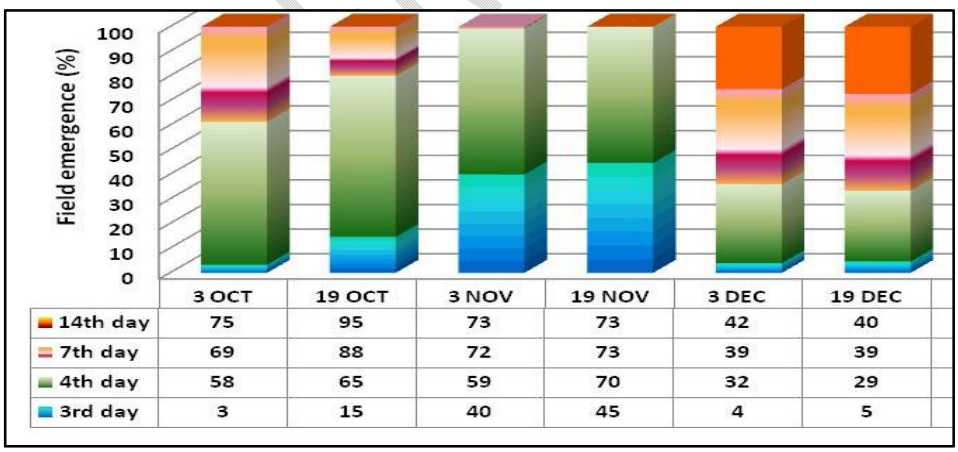
	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC	3 JAN
14th day	85	77	91	81	74	48	48
7th day	81	73	85	80	71	48	48
4th day	57	45	74	73	64	43	35
3rd day	15	11	35	57	49	5	7

Fig. 9. Field emergence (%) tested at 1 month after harvest of JS 335 grown under different dates of sowing



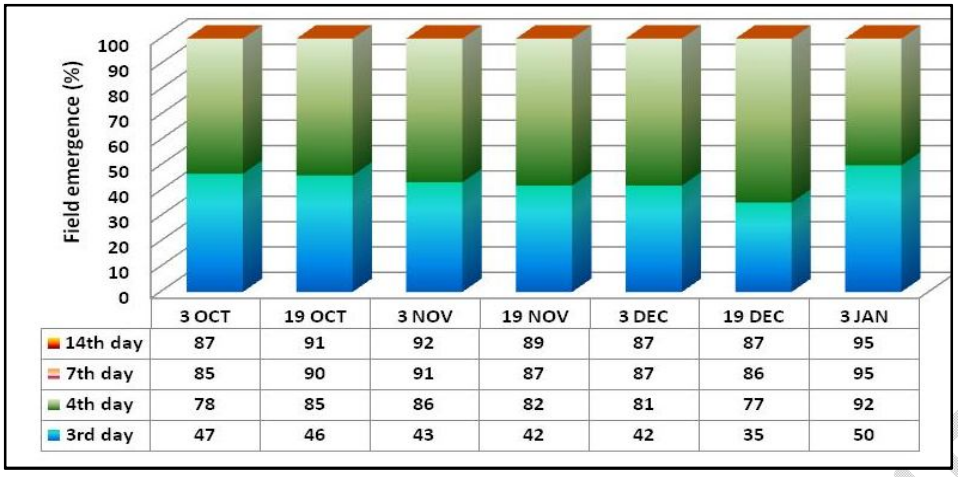
	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC	3 JAN
14th day	85	83	96	78	75	59	59
7th day	81	81	94	77	72	59	59
4th day	59	61	90	74	72	51	45
3rd day	19	3	53	59	57	20	16

Fig. 10. Field emergence (%) tested at 1 month after harvest of ASB 22 grown under different dates of sowing



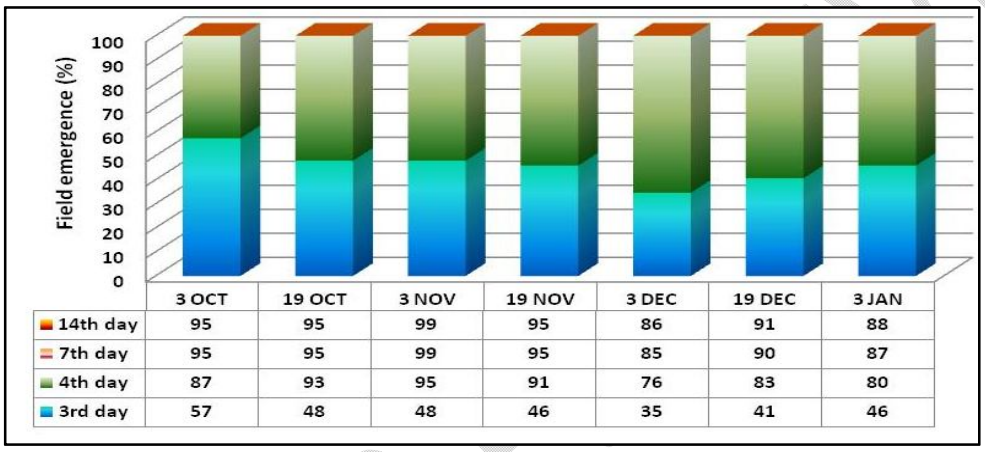
	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC
14th day	75	95	73	73	42	40
7th day	69	88	72	73	39	39
4th day	58	65	59	70	32	29
3rd day	3	15	40	45	4	5

Fig. 11. Field emergence (%) tested at 1 month after harvest of KDS 726 grown under different dates of sowing



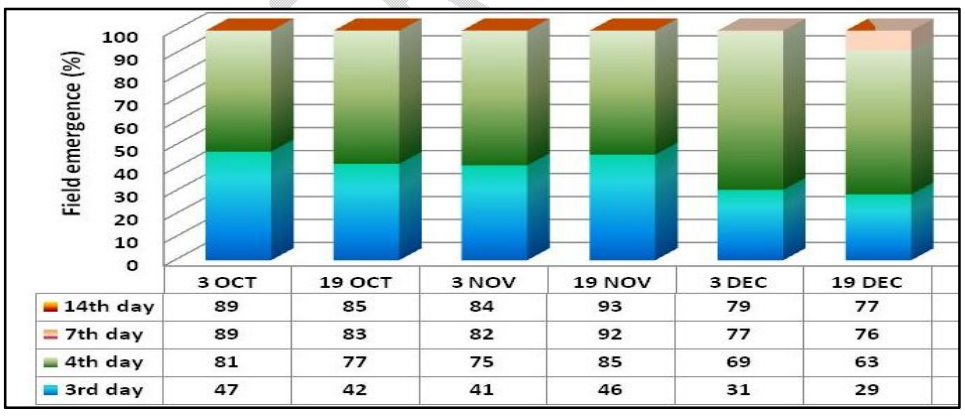
	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC	3 JAN
14th day	87	91	92	89	87	87	95
7th day	85	90	91	87	87	86	95
4th day	78	85	86	82	81	77	92
3rd day	47	46	43	42	42	35	50

Fig. 12. Field emergence (%) tested in June month of JS 335 grown under different dates of sowing



	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC	3 JAN
14th day	95	95	99	95	86	91	88
7th day	95	95	99	95	85	90	87
4th day	87	93	95	91	76	83	80
3rd day	57	48	48	46	35	41	46

Fig. 13. Field emergence (%) tested in June month of ASB 22 grown under different dates of sowing



	3 OCT	19 OCT	3 NOV	19 NOV	3 DEC	19 DEC
14th day	89	85	84	93	79	77
7th day	89	83	82	92	77	76
4th day	81	77	75	85	69	63
3rd day	47	42	41	46	31	29

Fig. 14. Field emergence (%) tested in June month of KDS 726 grown under different dates of sowing

CONCLUSIONS

The present investigation proved that the quality seed of soybean crop can be produced with*cv.* ASB 22 with the first week of Octsowing during the off-season in the Northern Telangana zone in India.

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