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Phenological responses of soybean (*Glycine max* L.) to different sowing dates during the off-season in Northern Telangana zone

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Abstract

Aims: To identify the optimum sowing time and suitable varieties of soybean for profitable cultivation during off season in 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 with three varieties and 9 dates of sowing. 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 number of days taken to emergence of 50% seedlings, bud appearance, 1st flower appearance, 1st pod appearance, 1st pod dry and 75% of pods dry stages was counted based on morpho physiological appearance of 50% plants in net plot area and expressed in days and analyzed statistically using OP Stat.

Results: The cv. KDS 726 taken more number of days to bud appearance, 1st flower appearance, 1st pod appearance, 1st pod dry and 75% pods dry stages followed by the cv. ASB 22 and least was with the cv. JS 335.

Conclusion: Sowing date had a minor impact on emergence, it significantly affected later stages like bud appearance, flower, and pod formation and the cv. KDS 726 taken more number of days to bud appearance, 1st flower appearance, 1st pod appearance, 1st pod dry and 75% pods dry stages followed by the cv. ASB 22 and least was with the cv. JS 335.

Keywords: Soybean, off season, varieties, Dates of sowing, phenology

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) [6]. 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 tones and productivity of 1069 kg ha⁻¹ (Indiastat, 2021) [3]. 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 tonnes and productivity of 1731 kg ha⁻¹ (Indiastat, 2021) [3]. Though the soybean crop has immense opportunity in global market, yields are extremely less than its potential yield in Telangana. In Telangana, the soybean crop is cultivated during *kharif* season. The main factors that reduce its yields are climate unevenness, in appropriate growing time, lower germination percentage, meager quality and scarcity of seed. Further the viability and longevity of soybean seeds very low. Therefore, there is a less 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

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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 maximizing seed yield during 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 $\times$ environment interactions to identify the varieties which are stable in different environments (Calvino *et al.*, 2003) [1]. 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 growth of soybean during the off-season in Northern Telanagana zone.

2. Materials and Methods

A field experiment was conducted during off-season 2022-23 at Regional Sugarcane & Rice Research Station, Rudrur, Nizamabad. Which is geographically located at 18°56' N latitude and 77°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 (V₁), ASB 22 (V₂) and KDS 726 (V₃) as horizontal strips and nine dates of sowings viz., 3 Oct (D₁), 19 Oct (D₂), 3 Nov (D₃), 19 Nov (D₄), 3 Dec (D₅), 19 Dec (D₆), 3 Jan (D₇), 19 Jan (D₈) and 3 Feb (D₉) as vertical strips, replicated thrice. A seed rate of 75 kg ha⁻¹ was used for sowing. The spacing adopted was 45 cm $\times$ 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 - P₂O₅ - K₂O) kg ha⁻¹ was applied to soybean crop, in the form of urea, single super phosphate and 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 number of days taken to emergence of 50% seedlings, bud appearance, 1st flower appearance, 1st pod appearance, 1st pod dry and 75% of pods dry stages was counted based on morpho physiological appearance of 50% plants in net plot area and expressed in days and analyzed statistically using OP Stat.

3. Results and Discussion

1. Phenology (Days)

Days to emergence (50% seedlings)

The duration of emergence of soybean cultivars and their interaction with dates of sowing did not differ significantly (Table 1). This result indicates that, the speed of germination and emergence of soybean cultivars was not sensitive to the

variable set of weather conditions prevailed during this phase under different dates of sowings.

Days to buds appearance stage

The days to attain bud appearance stage was influenced by the interaction effects of varieties and sowing dates (Table 1). In 19 Oct (D₂) sowing, the cv. KDS 726 (V₃) took 34 days to attain bud appearance stage which was significantly more than the cv. JS 335 (31 days) and cv. ASB 22 (30 days). However, the days to bud appearance of cultivars JS 335 (31 days) and ASB 22 (30 days) were comparable to each other. Similar trend was also reflected in D₄, D₆, D₈ and D₉ sowing dates. Whereas, in 3 Nov sowing, the days to bud appearance of cv. KDS 726 (34 days) was comparable with cv. ASB 22 (32 days) and significantly more over cv. JS 335 (30 days). Further, in 3 Dec sowing the more number of days to bud appearance was observed in cv. KDS 726 (33 days) which was comparable with cv. JS 335 (31 days) and significantly more over cv. ASB 22 (30 days). But in 3 Oct and 3 Jan sown crops no significant variation in days to bud appearance stage was noticed among the cultivars. The more number of days to attain bud appearance was registered by the cv. KDS 726 across the sowing dates over cv. JS 335 (V₁) and cv. ASB 22 (V₂) might be due to its inherent genetical property. These results are in accordance to the findings of Gochar *et al.* (2022) [2]. The individual varietal performance under different dates of sowing showed that, the cv. JS 335 (V₁) required 39 days to attain bud appearance when it was sown on 3 Oct (D₁) which was significantly longer than all its succeeding dates sowings. But, when it was sown on 19 Nov (D₄) required only 28 days to reach bud appearance stage. However, it was at par with D₂, D₃, D₅, D₆, D₇ and D₈ date sowings. The more number of days (39 days) to reach bud appearance of cv. ASB 22 (V₂) was observed in 3 Oct (D₁) sown crop which was significantly more than the all other sowing dates. The shorter span of 28 days to attain bud appearance was observed in 19 Dec (D₆) date sown crop. However, it was comparable with D₂, D₄, D₅, D₇, D₈ and D₉ dates sown crops. The maximum number of days (40 days) to attain bud appearance of cv. KDS 726 was observed in 3 Oct (D₁) sown crop which was significantly more than the all other sowing dates. The minimum number of days (30 days) to reach bud appearance was noticed with the crop sown on 3 Jan (D₇). However, it was comparable with D₅ and D₆ date sown crops. The reduced photoperiod or shorter day length with huge difference in maximum and minimum temperatures restricted the vegetative growth and triggered the reproductive phase very quickly resulting in early completion of vegetative phase (Oad *et al.*, 2002) [7]. Similar results were also demonstrated by Khan *et al.* (2003) [5].

Days to 1st flower appearance stage

The days to attain this stage was influenced by interaction effect of varieties and sowing dates (Table 1). The cv. KDS 726 (V₃) sown on 3 Nov (D₃) took significantly maximum number of days (47 days) to reach 1st flower appearance stage which was 11 and 8 days more over cv. JS 335 (11 days) and cv. ASB 22 (8 days), respectively. This trend was also reflected in its preceding D₂ and succeeding D₄, D₆, D₇ and D₈ dates sown crops. Further, in 3 Oct and 3 Dec sown crops there was no significant variation among the cultivars was noticed in days to 1st flower appearance stage. The more number of days to attain 1st flower appearance stage registered by the cv. KDS 726 across the sowing dates over cv. JS 335 (V₁) and cv. ASB 22 (V₂) might be due to its

inherent genetical property. Individual varietal performance under different dates of sowing showed that, the cv. JS 335 (V₁) has taken more number of days (42 days) to attain 1st flower appearance stage in 3 Oct (D₁) sowing which was comparable with D₅, D₈ and D₉ and significantly more over rest of the sowing dates. The minimum number of days (36 days) to reach 1st flower appearance stage was noticed in 19 Oct (D₂) sowing which was comparable with all its succeeding dates sown crops. The cv. ASB 22 (V₂) took 43 days to reach 1st flower appearance stage in 3 Oct (D₁) date sown crop which was significantly more over all its succeeding dates sowings. The 19 Oct (D₂) sowing was taken least number of days (35 days) to attain 1st flower appearance stage which was at par with D₄, D₆ and D₇ and remained significantly lower than rest of the dates sown crops. The cv. KDS 726 (V₃) took a maximum number of days (47 days) to reach 1st flower appearance stage in 3 Nov (D₃) date sown crop which was on par with D₂, D₈ and D₉ and significantly more than the rest of the date sown crops. The minimum number of days (41 days) to attain 1st flower appearance stage was noticed in 19 Nov (D₄) sown crop which was comparable with D₁, D₂, D₅, D₆ and D₇ and significantly less than all other dates of sowings. These results are in line with the findings of Gochar *et al.* (2022)^[2].

Days to 1st pod appearance stage

The days to attain 1st pod appearance stage was influenced by interaction effect of varieties and sowing dates (Table 1). The cv. KDS 726 (V₃) sown on 3 Feb (D₂) took significantly more number of days (56 days) to reach 1st pod appearance stage which was 12 and 8 days more over cv. JS 335 (12 days) and cv. ASB 22 (8 days), respectively. A similar trend was also observed in D₂, D₃, D₄, D₆, D₇ and D₈ date sowings. But in 3 Oct and 3 Dec sown crops, there was no significant variation among the cultivars was noticed in days to 1st pod appearance stage. The above results indicate that, the difference in duration among the cultivars required from 1st flower appearance to 1st pod appearance largely governed by prevailing weather conditions and cultivar sensitivity. Individual varietal performance under different dates of sowing showed that, the cv. JS 335 (V₁) has taken more number of days (46 days) to attain 1st pod appearance stage in 3 Oct (D₁) sowing which was comparable with D₃, D₄, D₅, D₆, D₈ and D₉ sowings and significantly more over rest of the dates sown crops. The minimum number of days (40 days) to reach 1st pod appearance stage was observed in 19 Oct (D₂) sowing which was comparable with D₃, D₄, D₅, D₆, D₇ and D₉ sowings remained significantly inferior to the rest of dates sown crops. The cv. ASB 22 (V₂) attained 1st pod appearance stage in 48 days with 3 Feb (D₉) date sown crop which was on par with D₁, D₃, D₅, D₇ and D₈ sowing dates and significantly more over rest of the dates sown crop. The minimum number of days (39 days) to attain 1st pod appearance stage was noticed in 19 Oct (D₂) sowing which was at par with D₄ and D₆ dates sowings and remained significantly inferior to rest of the date sown crops. The cv. KDS 726 (V₃) took the maximum number of days (56 days) to reach 1st pod appearance stage in 3 Feb (D₉) date sown crop which was on par with D₃, D₇ and D₈ sowings and significantly more over remaining dates of sowings. The minimum number of days (46 days) to attain 1st

pod appearance stage was noticed in 3 Oct (D₁) sown crop which was comparable with D₄, D₅ and D₆ significantly lower to all other dates of sowings.

Days to 1st pod dry stage

The days to attain 1st pod dry stage influenced by interaction effect of varieties and sowing dates (Table 1). The cv. KDS 726 (V₃) sown on 19 Dec (D₆) taken more number of days (92 days) to attain 1st pod dry stage which was significantly more over cv. JS 335 (V₁) and cv. ASB 22 (V₂). This trend was also reflected in D₂, D₃, D₄, D₅, D₇, D₈ and D₉ date sown crops. The days to attain 1st pod dry stage was on par with each other among the cultivars in 3 Oct (D₁) sowing date. Individual varietal performance under different dates of sowing showed that, The cv. JS 335 (V₁) required 80 days to attain 1st pod dry stage in 19 Jan (D₈) sown crop which was comparable with 3 Nov (D₃) sown crop and significantly more over rest of the dates of sowings. The minimum number of 68 days to reach 1st pod dry stage was noticed in 19 Oct (D₂) sowing. Similar trend was also exhibited by the cv. ASB 22 (V₂). The cv. KDS 726 (V₃) took the maximum number of days (92 days) to reach 1st pod dry stage in 19 Dec (D₆) date sown crop which was comparable with D₃, D₇ and D₈ and significantly more over remaining dates sown crop. The lower number of days (73 days) to attain 1st pod dry stage was noticed in 3 Oct (D₁) sown crop.

Days to 75% pods dry stage

A significant difference was observed in days to attain 75% pods dry stage with their interaction effect (Table 1). The perusal of data from the Table 1 revealed that, the cultivars did not differ significantly to attain 75% pods dry stage in D₁ and D₉ dates sowings. The cv. KDS 726 (V₃) sown on 19 Dec (D₆) was taken 99 days to attain 75% pods dry stage which was significantly more over cv. JS 335 (79 days) and cv. ASB 22 (82 days). This similar trend was also noticed in D₂, D₃, D₄, D₅, D₇ and D₈ date sown crops. Individual varietal performance under different dates of sowing showed that, the cv. JS 335 (V₁) took 86 days to attain 75% pods dry stage in 19 Jan (D₈) sown crop which was on par with D₃, D₆ and D₉ sowings and significantly more over remaining dates sown crop. The minimum number of days (75 days) to attain 75% pods dry stage was noticed in 3 Oct (D₁) sowing which was comparable with D₂ to D₇ and D₉ sowings and remained significantly lower to the rest of the dates sown crop. The cv. ASB 22 (V₂) required 85 days to reach 75% pods dry stage in 19 Jan (D₈) sown crop which was comparable with D₃, D₄, D₆, D₇ and D₉ sowings and significantly more over remaining dates sown crop. The minimum number of days (77 days) to attain 75% pods dry stage was noticed in 3 Oct (D₁) sowing which was on par with D₂ to D₇ and D₉ dates sowings and remained significantly inferior to rest of the dates sown crops. The cv. KDS 726 (V₃) reached 75% pods dry stage within 99 days in 19 Dec (D₆) date sown crop which was on par with D₃, D₇ and D₈ sowing dates and significantly more than the rest of the dates sowings. The least number of days (78 days) to attain 75% pods dry stage was observed in 3 Oct (D₁) sown crop which was comparable to D₉ sowing date and significantly lower to all other dates of sowings. Similar findings were also reported by Gochar *et al.* (2022)^[2] and Kandil *et al.* (2019)^[4].

Table 1: Phenology (days) of soybean varieties as influenced by different dates of sowing

Varieties / Dates of sowing	(D ₁) 3 Oct	(D ₂) 19 Oct	(D ₃) 3 Nov	(D ₄) 19 Nov	(D ₅) 3 Dec	(D ₆) 19 Dec	(D ₇) 3 Jan	(D ₈) 19 Jan	(D ₉) 3 Feb	Mean		Varieties	Dates of sowing	Varietal means at the same level of dates of sowing	Dates of sowings means at the same level of variety
Days to emergence (50% seedlings)															
(V ₁) JS 335	7	7	7	7	7	7	8	7	8	7	S.Em±	0.2	0.2	0.3	0.3
(V ₂) ASB 22	7	7	7	7	7	7	7	8	7	7	CD	NS	NS	NS	NS
(V ₃) KDS 726	7	7	7	8	7	7	8	8	7	7	(p=0.05)				
Mean	7	7	7	7	7	7	8	8	7		CV (%)	11	8	8	8
Days to bud appearance stage															
(V ₁) JS 335	39	31	30	28	31	29	28	31	33	31	S.Em±	0.3	0.6	0.8	0.9
(V ₂) ASB 22	39	30	32	30	30	28	29	31	31	31	CD	1	2	2	3
(V ₃) KDS 726	40	34	34	35	33	33	30	36	36	35	(p=0.05)				
Mean	40	31	32	31	31	30	29	33	33		CV (%)	5	6	4	4
Days to 1st flower appearance stage															
(V ₁) JS 335	42	36	36	36	39	36	36	39	39	38	S.Em±	0.5	0.7	1.2	1.2
(V ₂) ASB 22	43	35	39	36	39	35	37	39	39	38	CD	2	2	4	3
(V ₃) KDS 726	43	44	47	41	41	41	43	45	45	43	(p=0.05)				
Mean	43	39	41	38	39	37	38	41	41		CV (%)	6	5	5	5
Days to 1st pod appearance stage															
(V ₁) JS 335	46	40	43	42	43	42	41	46	44	43	S.Em±	0.6	1.2	1.3	1.5
(V ₂) ASB 22	47	39	44	42	44	41	44	44	48	44	CD	2	4	4	4
(V ₃) KDS 726	46	53	54	48	46	49	52	54	56	51	(p=0.05)				
Mean	46	44	47	44	45	44	46	48	49		CV (%)	7	8	4	4
Days to 1st pod dry stage															
(V ₁) JS 335	70	68	77	71	71	70	70	80	74	72	S.Em±	0.7	0.8	1.5	1.4
(V ₂) ASB 22	72	70	79	72	71	68	74	80	72	73	CD	3	3	5	4
(V ₃) KDS 726	73	82	88	81	85	92	88	89	80	84	(p=0.05)				
Mean	72	73	81	75	76	77	78	83	76		CV (%)	5	3	3	3
Days to 75% pods dry stage															
(V ₁) JS 335	75	75	82	78	77	79	75	86	82	79	S.Em±	0.8	1.4	2.3	2.3
(V ₂) ASB 22	77	77	82	78	75	82	81	85	80	80	CD	3	4	7	7
(V ₃) KDS 726	78	88	93	89	89	99	95	97	85	90	(p=0.05)				
Mean	77	80	86	82	80	87	84	90	82		CV (%)	5	5	5	5

4. Conclusion

From the above results it can be concluded that sowing date had a minor impact on emergence, it significantly affected later stages like bud appearance, flower, and pod formation and the cv. KDS 726 taken more number of days to bud appearance, 1st flower appearance, 1st pod appearance, 1st pod dry and 75% pods dry stages followed by the cv. ASB 22 and least was with the cv. JS 335.

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