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Effect of sowing dates on dry matter partioning, yield and economics of soybean varieties during *kharif* season

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Abstract
The study was conducted during the *kharif* season of 2024 at the experimental farm of Department of Agronomy, College of Agriculture, V.N.M.K.V, Parbhani (M.S). The experimental design followed a split-plot arrangement, featuring 3 sowing dates (D_1 - SMW 25, D_2 - SMW 26, D_3 - SMW 27) as the main plots and 4 different varieties (V_1- JS 93-05, V_2 - MAUS 612, V_3 - MAUS 725, V_4 - MAUS 731) as subplots, replicated three times. Study shows that sowing dates and varieties significantly affected the dry matter partioning, yield attributes and economics. The study showed that sowing date D_2 (SMW 26) recorded maximum Dry matter partioning, seed yield and economics at all periodical intervals and at harvest and it was found at par with sowing date D_1 (SMW 25) and variety V_2 (MAUS 612) recorded maximum Dry matter partioning, seed yield, straw yield, biological yield and economics at all periodical intervals and at harvest and it found at par with variety V_4 (MAUS 731).

Keywords: Soybean, sowing date, varieties

Introduction
Soybean (*Glycine max* L. Merrill) is an important crop both globally and in India. This legume thrives in tropical and subtropical weather conditions. Commonly known as the 'Miracle crop', 'Wonder crop', or the 'Golden bean' of the 21st century, the soybean has its origins in China and was brought to India in 1968 from the United States.
Adverse climatic factors such as excessive rainfall and high humidity during the kharif season negatively impact seed yield and quality by increasing vulnerability to pests, insects, and diseases. These unfavorable environmental conditions not only reduce yield but also lower the germination percentage of *kharif* produced seeds. Additionally, delayed harvesting due to persistent rains can cause grain shattering and deterioration in seed quality.
Soybean is recognized as a short-day plant that reacts to variations in light conditions (Li *et al.* (2024) [5], and its yield is affected by the timing of planting (Shegro K. S. *et al*. (2019) [10]. Even with the prevalent adoption of enhanced, high-yield varieties in key soybean cultivation regions, recent climate-related issues have hindered the crop's ability to achieve its maximum yield potential. Important environmental elements such as precipitation and temperature significantly influence the growth, reproductive processes, and ultimate yield of soybean. The timing of sowing impacts the developmental stages of soybean because of shifts in day length (photoperiod) (Kumudini *et al.* 2007) [4], air temperature (Chen and Wiatrak, 2010) [1], and rainfall trends during the growing season (Hu and Wiatrak, 2012) [2]. Therefore keeping the view all above facts the present study is conducted.

Materials and Methods
The field experiment was conducted at experimental farm, Department of Agronomy, College of agriculture, V.N.M.K.V. Parbhani (M.S) during *kharif* 2024. The site was located $19^0 16'$ North latitude and $76^0 47'$ East longitude and at 409 altitudes above mean sea level and has a semi- arid climate. The experiment was laid out in Split plot design (SPD) with 3 main plot of sowing dates and 4 sub plot of four varieties with 3 replications. The experiment consist of 3 sowing dates D_1 (SMW 25), D_2 (SMW 26), D_3 (SMW 27) and 4 different varieties V_1 (JS 93-05), V_2 (MAUS

612), V_3 (MAUS 725), V_4 (MAUS 731). The gross plot size was 5.4 m x 4.5 m and net plot size was 4.5 m x 4.1 m. The soil of experimental site was black loamy. Plant protection measures were taken as per the recommended schedule. The data collected on yield contributing characters like number of pods plant^{-1}, number of seed pod^{-1}, Test weight, Seed yield. The data collected from the randomly selected five plants in each plot at 30,60,90 DAS and at harvest.

Result and Discussion-

Sowing date

The sowing dates have significant impact on dry matter partioning of stem, leaves, pods weight plant^{-1} during 30,60,90 DAS and at harvest, among the different sowing dates, sowing date D_2 (SMW 26) recorded significantly highest dry matter weight production than sowing date D_3 (SMW 27) and it was found at par with sowing date D_1 (SMW 25), lowest dry matter weight recorded by sowing date D_3 (SMW 27). This is due to congenial crop growth conditions that sowing date D_2 (SMW 26) received sufficient rainfall and adequate moisture to aid in the crop growth and development. Similar result observed by Park *et al.* (2000) [8] and Kumar A *et al.* (2008) [3].

The sowing date have significant impact on seed yield, straw yield, biological yield. Among the different sowing dates, sowing date D_2 (SMW 26) produced the maximum seed yield, straw yield, biological yield than sowing date D_3 (SMW 27) and it was found at par with sowing date D_1 (SMW 25), lowest seed yield, straw yield, biological yield produced by sowing date D_3 (SMW 27). This might be due to the favourable temperature and photoperiod during sowing date D_2 (SMW 26). Similar result obtained by Nath *et al.* (2017) [7]. In terms of harvesting index highest harvesting index obtained by sowing date D_2 (SMW 26) and lowest harvesting index obtained by sowing date D_3 (SMW 27).

The sowing dates have significant impact on economics, among the different sowing dates, sowing date D_2 (SMW 26) recorded highest gross monetary returns, net monetary returns and benefit cost ratio than sowing date D_1 (SMW 25) and sowing date D_3 (SMW 27).

Varieties

The different varieties have significant impact on dry matter partioning of stem, leaves, pods weight plant^{-1} during 30,60,90 DAS and at harvest, among the different varieties, variety V_2 (MAUS 612) recorded highest dry matter weight production than varieties V_1 (JS 93-05) and V_3 (MAUS 725) it was found at par with variety V_4 (MAUS 731) and the lowest dry matter were recorded by variety V_1 (JS 93-05). This might be due to the varietal character. Similar result were observed by Ramana *et al.* (2012) [9] and Naidu *et al.* (2017) [6].

The different varieties have significant impact on seed yield, straw yield, biological yield. Among the different varieties, variety V_2 (MAUS 612) produced the maximum seed yield, straw yield, biological yield than varieties V_1 (JS 93-05) and V_3 (MAUS 725) it found at par with variety V_4 (MAUS 731), lowest yield produced by variety V_1 (JS 93-05). This might be due to varietal characters. In terms of harvesting index highest harvesting index obtained by variety V_3 (MAUS 725) and lowest harvesting index obtained by variety V_1 (JS 93-05).

Different varieties have significant impact on economics, among the different varieties, variety V_2 (MAUS 612) recorded highest gross monetary returns, net monetary returns than variety V_1 (JS 93-05), V_3 (MAUS 725) and V_4 (MAUS 731). And in terms of benefit cost ratio variety V_3 recorded highest benefit cost ration and lowest ratio recorded by variety V_1 (JS 93-05).

Interaction

The interaction effect between sowing dates and varieties found to be non significant for dry matter partioning, seed yield, straw yield, biological yield, gross monetary returns, net monetary returns.

Table 1: Dry matter partitioning weight plant^{-1} (g) as influenced periodically by different sowing dates and varieties of soybean.

Treatments	Dry matter accumulation of stem weight plant^{-1}				Dry matter accumulation of leaves weight plant^{-1}			Dry matter accumulation of pod weight plant^{-1}			Total dry matter accumulation weight plant^{-1}			
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
Sowing dates														
D_1-SMW 25	1.00	1.84	2.01	2.55	2.08	6.08	1.62	4.97	16.67	21.26	3.09	12.89	20.31	23.81
D_2- SMW 26	1.50	2.08	2.54	3.34	2.54	7.06	2.94	5.50	17.54	23.61	4.04	14.65	23.04	26.95
D_3- SMW 27	0.84	1.59	1.82	2.07	1.52	5.07	1.25	2.59	13.80	14.58	2.36	9.26	16.88	16.65
S.Em.±	0.02	0.06	0.09	0.06	0.05	0.08	0.03	0.18	0.36	0.66	0.12	0.48	0.75	0.89
C. D. at 5%	0.10	0.24	0.35	0.23	0.22	0.31	0.13	0.70	1.44	2.60	0.48	1.90	2.97	3.50
Varieties														
V_1- JS 93-05	0.70	1.32	1.57	2.19	1.72	5.73	1.27	2.42	14.10	15.70	2.43	9.47	16.96	17.89
V_2 - MAUS 612	1.45	2.30	2.55	3.04	2.44	6.37	2.50	5.62	17.66	22.40	3.89	14.30	22.72	25.44
V_3- MAUS 725	1.00	1.61	2.02	2.52	1.96	5.91	1.81	4.61	15.77	20.36	2.96	12.14	19.61	22.88
V_4- MAUS 731	1.31	2.12	2.36	2.86	2.07	6.26	2.16	4.76	16.48	20.80	3.38	13.15	21.01	23.67
S.Em.±	0.04	0.09	0.09	0.09	0.07	0.14	0.09	0.16	0.51	0.58	0.11	0.44	0.72	0.81
C.D. at 5%	0.12	0.27	0.28	0.29	0.21	0.41	0.28	0.47	1.52	1.74	0.34	1.33	2.15	2.43
Interaction														
S.Em.±	0.07	0.16	0.16	0.17	0.12	0.24	0.16	0.27	0.88	1.01	0.20	0.77	1.25	1.41
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	11.30	15.05	13.49	11.15	10.78	6.96	14.69	11.09	9.61	8.90	10.9	10.95	10.81	10.92
G. Mean	1.17	1.84	2.13	2.65	2.05	6.07	1.94	4.35	16.00	19.81	3.16	12.27	20.08	22.47

Table 2: Seed, straw and biological yield (kg ha^{-1}) and harvest index (%) of soybean as influenced by different sowing dates and varieties of soybean

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Sowing dates				
D_1-SMW25	2280.00	2869.00	5149.03	44.23
D_2-SMW26	2446.66	3007.50	5454.16	44.78
D_3-SMW27	2095.83	2566.66	4662.50	44.84
S.Em.±	62.32	64.08	78.30	--
C.D. at 5%	244.67	251.43	307.42	--
Varieties				
V_1-JS 93-05	1904.44	2611.11	4515.55	42.13
V_2-MAUS 612	2490.66	3010.93	5501.59	45.28
V_3-MAUS 725	2263.77	2644.44	4908.22	46.16
V_4-MAUS 731	2437.77	2991.11	5428.88	44.90
S.Em.±	61.42	70.48	144.20	--
C.D. at 5%	182.51	209.43	428.46	--
Interaction(D x V)				
S.Em.±	106.39	122.08	249.76	--
C.D. at 5%	NS	NS	NS	--
C.V. (%)	8.10	7.51	8.50	--
G. mean	2274.16	2814.39	5088.56	44.62

Table 3: Gross monetary returns, Net monetary returns (₹ ha^{-1}) and B: C ratio of soybean as influenced by different sowing dates and varieties of soybean

Treatment	Gross monetary returns (₹ ha^{-1})	Net monetary returns (₹ ha^{-1})	B:C ratio
Sowing dates			
D_1-SMW25	111529.4	40258.9	1.56
D_2-SMW26	119690.9	47839.4	1.66
D_3-SMW27	102528.1	32167.6	1.45
S.Em.±	1225.62	1647.21	--
C.D. at 5%	4811.61	6466.73	--
Varieties			
V_1-JS 93-05	93154.6	23199.2	1.33
V_2-MAUS 612	121843.4	49837.0	1.69
V_3-MAUS 725	110743.9	39882.6	1.56
V_4-MAUS 731	119256.0	47435.6	1.66
S.Em.±	2599.84	1490.34	--
C.D. at 5%	7224.82	4428.21	--
Interaction(D x V)			
S.Em.±	4503.06	2581.35	--
C.D. at 5%	NS	NS	--
C.V. (%)	7.01	11.15	
G. mean	111249.4	40088.6	1.56

Conclusion

- Sowing date D_2 (SMW 26) found to suitable for highest dry matter partioning, seed yield, straw yield, biological yield, harvesting index with higher gross monetary returns, net monetary returns, and benefit cost ratio.
- Among the different varieties, variety V_2 (MAUS 612) and variety V_4 (MAUS 731) performed better in dry matter partioning, seed yield, straw yield, biological yield and higher gross monetary returns, net monetary returns, than varieties V_1 (JS 93-05), V_3 (MAUS 725).

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