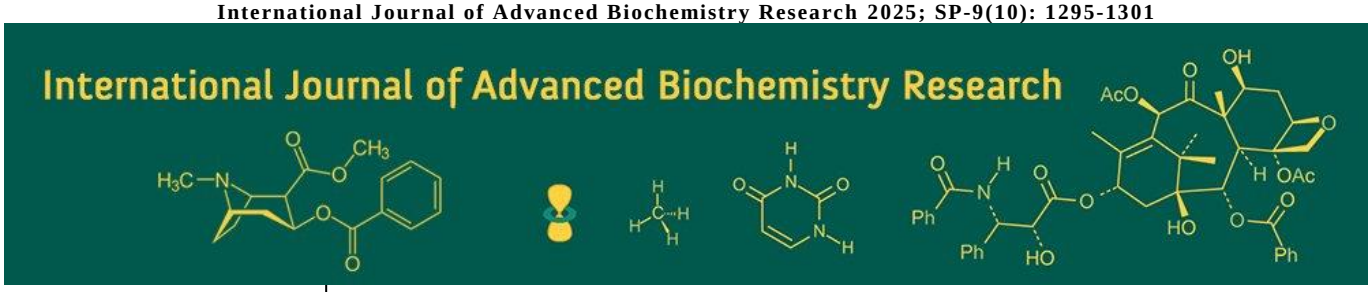

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Effect of different seed rates on yield and yield components of released and pre-released varieties of soybean

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Abstract
The field investigation was conducted at Regional Research Centre, Amravati under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Kharif 2020-21 to 2022-23. The experiment was laid out in a Factorial Randomized Block Design with twelve treatments combinations (Factor A: Varieties-V_1: AMS 1001 (PDKV Yellow Gold), V_2: AMS-MB 5-18 (Suvarn Soya), V_3: AMS 100-39 (PDKV Amba) and V_4: JS 93-05 and Factor B: Seed rate-S_1: 50 kg ha^{-1}, S_2: 62.5 kg ha^{-1} and S_3: 75 kg ha^{-1}) with three replications.

From pooled data over the three years revealed that, variety AMS-100-39 (PDKV Amba) showed significantly superior over rest of the varieties in respect of seed yield (2403 kg ha^{-1}), straw yield (2903 kg ha^{-1}) and also recorded higher gross monetary returns (Rs.101748 Rs ha^{-1}), net monetary returns (60734 Rs ha^{-1}) and B:C ratio (2.48). Seed rate 62.5 kg ha^{-1} was found significantly superior over all other seed rate i.e. Seed rate 50 kg ha^{-1} and seed rate 75 kg ha^{-1} in respect of seed yield (2296 kg ha^{-1}), gross monetary returns (96941Rs ha^{-1}), net monetary returns (55964 Rs ha^{-1}) and B:C ratio (2.37). Pooled results revealed that in variety x seed rate interaction, variety AMS-1001 (PDKV Yellow Gold), AMS-MB 5-18 (Suvarn Soya) and AMS 100-39 (PDKV Amba) recorded higher seed yield, straw yield, gross monetary returns and net monetary returns with seed rate 62.5 kg ha^{-1}.

Keywords: Soybean, genotypes, seed rate, released, pre-released

Introduction

Soybean has emerged as one of the major oilseed crop and revolutionized rural economy and lifted the socio economic status of soybean farmers. However, the increase in the productivity over the years did follow the same place, and it is not more than half of the world average, hence there is tremendous scope to increase soybean production by enhancing productivity.

Seed is one of the most expensive input costs for soybean growers, so it's important for growers to plant the right amount of seed to minimize input costs and increase profitability. Seeding rate, plant population, and row spacing are tied together. If the population is too high, plants compete with each other and often lodge. If the population is too low, a producer is wasting growing space and lowering yield. This publication examines the relationship between soybean seeding rate and plant population, describes how to determine the right seeding rates for optimal plant populations, and recommends seeding rates and plant populations for various crop row widths. High plant populations can have some advantages: canopy closure is quicker, light interception is greater, and weed competition is lower. However, yield does not always increase as plant population increases. As the number of plants per hectare increases, each plant captures less light, which limits each plant's growth. High plant populations also increase competition for nutrients and water, may promote lodging, and add to seed costs. Soybean plants are adaptable. When plant populations are low, individual soybean plants increase their leaf area which allows each plant to capture more sunlight and produce more branches which allows each plant to produce more pods. This characteristic (called plasticity) means that low soybean plant populations can offer competitive yields. Determining Optimum Seeding Rate Many factors influence plant population and seeding rate, including row spacing, seed placement and planter calibration, and the seed's germination rate. Seeding rate, plant population, and row spacing are closely related.

To maximize yield and reduce input costs, soybean growers need to pay attention to plant populations and seeding rates. These recommendations present the optimal seeding rates and plant populations for different varities of soybean as the test weight of soybean varieties are different. Indian growers following them may reduce input costs and improve profitability.

The cost of soybean seed has increased over the last few years due to the shortage of good quality seed in market. The main objective of this study is to evaluate the effect of soybean seeding rate of different varieties on yield and to find an optimal seeding rate for different varieties of soybean that benefits the farmers by minimizing production input cost; thus maximizing net return.

Secondary objective of the study is to show soybean producers how reduced seeding rates may minimize input cost; without decreasing yield. Finding an optimal soybean seeding rate for different varieties of soybean will increase the overall profitability of the soybean crop. Finally, this research will show the economic impact on the soybean producer's net income as affected by seeding rate.

Hence considering these points in view the present study was undertaken with aim to study the "Effect of different seeding rates on yield and yield components of released and pre-released varieties of soybean".

Materials and Methods

The experiment was laid during *Kharif* 2020-21 to 2022-23 in FRBD with two factors i.e. Factor A: Variety (V1-AMS 1001 (PDKV Yellow Gold), V2-AMS-MB 5-18 (Suvarn Soya), V3-AMS 100-39 (PDKV Amba), V4-JS-93-05) and Factor B: Seedrate (50kg/ha (S_1), 62.50 kg/ha (S_2) and 75 kg/ha (S_3) with 3 replications and 12 treatments cominations at Regional Resaerch Station, Amravati under Dr. PDKV, Akola. The soil was medium black. The plot size Gross: 5.40 x 3.60 m and net plot size was 4.50 x 2.70 m. The recommended fertilizer dose of 30:60:30 NPK kg/ha was applied. The seeds were sown by dibbling. The seed yield and quality attributes were recorded during the crop growth and after harvest. The data obtained were analysed through analysis of variance (ANOVA) technique for factorial randomized block design and presented at 5% level of significance (P = 0.05) suggested by Panse and Sukhatme (1967) [22].

Results and Discussion

The effect of varieties and seedrate on growth and yield vary due to varietal characters of selected variety and seedrate adopted. Thus the relationship of seed yield with different growth parameters and yield components under variable seedrate and varieties is very important to understand the basic mechanism of yield-plant density relationship and this would also help in identification of suitable seedrate for improving yield of soybean.

Plant Height

Different varieties and seed rate plays important role in plant height. Pooled data over the three years in respect of plant height revealed that variety AMS MB-5-18 (Suvarn Soya) showed significantly higher plant height (56.26 cm) over variety JS 93-05 and AMS 1001 but at par with treatment V_3 (AMS 100-39 (PDKV Amba). Seedrate 75 kg ha^{-1} (S_3) recorded significantly highest plant height (56.66 cm) over rest of all other seedrate.

Table 1: Plant Height (cm) and number of branches/palnt of soybean as influenced by varieties and seedrate

	Plant Height (cm)				Number of branches per plant			
Treatments	**2020-21**	**2021-22**	**2022-23**	**Pooled Mean**	**2020-21**	**2021-22**	**2022-23**	**Pooled Mean**
Factor A: Varieties								
V1: AMS 1001 (PDKV Yellow Gold)	51.24	53.89	56.42	53.85	2.84	3.98	4.29	3.70
V2: AMS-MB 5-18 (Suvarn Soya)	54.19	56.39	58.20	56.26	2.87	4.04	4.24	3.72
V3: AMS 100-39 (PDKV Amba)	53.59	55.79	55.04	54.81	3.33	4.49	4.93	4.31
V4: JS 93-05	46.80	49.10	45.13	47.01	2.56	3.62	3.71	3.30
SE (m)±	1.08	1.07	0.75	0.69	0.10	0.10	0.13	0.09
CD at 5 %	3.18	3.15	2.19	2.01	0.28	0.29	0.38	0.26
Factor B: Seed rate								
S1: 50 $kgha^{-1}$	47.98	50.51	50.18	49.56	3.02	4.35	4.82	4.06
S2: 62.5 $kgha^{-1}$	51.11	53.31	53.77	52.73	3.00	4.22	4.37	3.91
S3: 75 $kgha^{-1}$	55.28	57.56	57.15	56.66	2.68	3.53	3.70	3.31
SE (m)±	0.94	0.93	0.65	0.59	0.08	0.09	0.11	0.08
CD at 5 %	2.75	2.73	1.89	1.74	0.24	0.25	0.33	0.22
Interaction								
SE (m)+	1.88	1.86	1.29	1.19	0.17	0.17	0.22	0.15
CD at 5 %	5.50	5.46	3.79	3.48	0.49	0.50	0.65	0.45
Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig

Table 2: Plant height (cm) as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	51.58	50.83	53.58	42.21
S2	52.21	56.66	54.46	47.56
S3	57.75	61.27	56.36	51.24
SE (m) ±	1.19			
CD at 5%	3.48			

Plant height was affected significantly due to interaction between variety and seedrate. Treatment combination V_2xS_3 recorded significantly higher plant height (61.27 cm) over other treatment combinations. Hamid *et al.* (2002) [11] also experimented on 40 kg ha^{-1}, 60 kg ha^{-1}, 80 kg ha^{-1} and 100 kg ha^{-1} seed rates and reported that plant height increased with an increase in seed rate.

Number of branches $plant^{-1}$

Three years pooled results showed that, significantly highest number of branches per plant was observed with variety AMS 100-39 (PDKV Amba) (4.31) over rest of all other varieties. Number of branches per plant was significantly

higher with seedrate (S_1) 50 kgha^{-1} (4.09) over the treatment S_3 (75 kgha^{-1}) but found at par with treatment S_2 (62.5 kgha^{-1}).

Number of branches plant^{-1} was recorded more in V_3xS_1 treatment combination (4.73) and significantly higher over all other treatment combinations but at par with treatment combinations V_3 x S_2 (4.66).

Table 3: Number of branches per plant at harvest as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	4.11	4.06	4.73	3.33
S2	3.80	3.80	4.66	3.35
S3	3.33	3.35	3.53	3.20
SE (m) ±	0.15			
CD at 5%	0.45			

The growth parameters were significantly influenced by seed rates at most of the crop growth stages. Verma *et al.* [2004] [34] and Nikam and Firake [2002] [20] have also reported higher plant population due to higher seed rate resulted from more vegetative growth. Bilal *et al.* [2009] [3] showed significant and consistent increase with the increase in seed rates at all growth stages of the crop.

The better plant growth in terms of plant height and number of branches due to optimum plant population might have resulted into higher N fixation etc. which might be responsible for better nodulation. Similar results were also reported by Jain *et al.* [1996] [14], Halvankar *et al.* [1999] [10], Ball *et al.* [2001] [2], Graterol and Montilla [2003] [9], Rambo *et al.* [2003] [24], Kumar and Badiyala [2004] [15], Verma *et al.* [2004] [34] and Lone *et al.* [2009] [19] and Taher-soula and Mohammadi [2013] [30]. The growth parameter like plant height, number of branches plant^{-1}, were significantly influenced by varieties at various growth stages. Plant height was affected by two varieties depend on their genetic characters and climatic condition. Similar results were also reported by Hassan *et al.* [2001] [12], Rezaieand Tajbakhsh [2002] [26], Rahman *et al.* [2011] [27] and Tahersoula and Mohammadi [2013] [30].

Number of pods plant^{-1}

Pooled data over the three years in respect of number of pods per plant at harvest resulted that, variety AMS-MB 5-18 (Suvarn Soya) recorded significantly more number of pods plant^{-1} (43.00) over rest of all varieties. Seed rate 50 kgha^{-1} (41.88) recorded significantly highest number of pods plant^{-1} over seedrate 75 kgha^{-1} (32.24) and 62.5 kgha^{-1} (38.08).

Table 4: Number of pods per plant and test weight at harvest of soybean as influenced by varieties and seedrate

	Number of pods per plant				Test Weight (g)			
Treatments	**2020-21**	**2021-22**	**2022-23**	**Pooled Mean**	**2020-21**	**2021-22**	**2022-23**	**Pooled Mean**
Factor A: Varieties								
V1: AMS 1001 (PDKV Yellow Gold)	34.56	35.75	36.11	35.47	10.44	10.46	10.44	10.45
V2: AMS-MB 5-18 (Suvarn Soya)	36.0	44.36	48.64	43.00	10.24	10.27	10.28	10.27
V3: AMS 100-39 (PDKV Amba)	37.67	43.72	40.53	40.64	11.32	11.31	11.34	11.32
V4: JS 93-05	34.44	29.71	28.51	30.84	12.11	12.07	12.08	12.09
SE (m)±	1.08	1.16	1.02	0.70	0.07	0.07	0.06	0.06
CD at 5 %	3.16	3.40	2.95	2.05	0.20	0.19	0.18	0.19
Factor B: Seed rate								
S1: 50 kgha^{-1}	38.92	42.22	44.50	41.88	11.28	11.26	11.29	11.27
S2: 62.5 k ha^{-1}	36.58	39.03	38.62	38.08	11.05	11.04	11.03	11.04
S3: 75 kgha^{-1}	31.50	33.90	32.22	32.24	10.76	10.78	10.79	10.78
SE (m)±	0.93	1.01	0.88	0.60	0.06	0.06	0.05	0.05
CD at 5 %	2.74	2.95	2.55	1.77	0.18	0.16	0.15	0.16
Interaction								
SE (m)+	1.87	2.01	1.77	1.21	0.12	0.11	0.10	0.11
CD at 5 %	5.48	5.90	5.18	3.54	0.35	0.33	0.31	0.32
Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig

Number of of pods plant^{-1} was recorded more in V_2xS_1 treatment combination (46.26) and significantly higher over other treatment combinations but at par with treatment combinations V_2 x S_2 and V_3 x S_1.

Table 5: Number of pods per plant at harvest as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	38.81	46.26	44.64	37.80
S2	37.59	43.01	40.94	30.75
S3	30.01	39.71	36.33	22.88
SE (m) ±	1.21			
CD at 5%	3.54			

Ram *et al.* (2011) [23] also reported the highest number of pods/plant with the seed rate of 50 kg/ha and significant decrease with each increment of 25 kg in seed rate. Ferreira *et al.* (2018) [8] also described reduced the number of pods/plant with increasing seeding rate.

Test Weight (g)

From three years pooled data it is noted that significantly highest test weight was observed with variety JS 93-05 (12.09 g) g) over the treatment V_1, V_2 and V_3. Pooled results showed that seedrate S_1 (50 kg ha^{-1}) indicated significantly

highest test weight over rest of the treatments (11.27g) Test weight was found higher in V_4xS_1 treatment combination (12.45 g) and significantly higher over other treatment combinations but at par with treatment combination V_4xS_2 (12.28 g).

Table 6: Test Weight (g) of soybean as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	10.69	10.45	11.49	12.45
S2	10.38	10.19	11.28	12.28
S3	10.25	10.14	11.18	11.52
SE (m) ±	0.11			
CD at 5%	0.32			

Seed yield (kgha^{-1})

Pooled data over the three years in respect of seed yield shows that, treatment V_3 i.e. variety AMS 100-39 (PDKV Amba) recorded significantly highest seed yield (2403 kg ha^{-1}) over variety AMS 1001(PDKV Yellow Gold) (2043 kg ha^{-1}), AMS-MB 5-18 (Suvarn Soya) (2204 kg ha^{-1}) and JS 93-05(1776 kg ha^{-1}). Seed rate 62.5 kg ha^{-1} recorded significantly highest seed yield (2296 kgha^{-1}) over seed rate 75 kg ha^{-1} (1970 kgha^{-1}) and seedrate 50 kg ha^{-1} (2053 kg ha^{-1}) in pooled results of three years data.

Table 7: Effect of varieties and seed rate on seed yield and Straw yield (kg/ha) of soybean

	Seed yield (kg/ha)				Straw yield (kg/ha)			
Treatments	**2020-21**	**2021-22**	**2022-23**	**Pooled Mean**	**2020-21**	**2021-22**	**2022-23**	**Pooled Mean**
Factor A: Varieties								
V1: AMS 1001 (PDKV Yellow Gold)	2006	2009	2114	2043	2608	2561	2696	2621
V2: AMS-MB 5-18 (Suvarn Soya)	2129	2173	2311	2204	2696	2688	2857	2747
V3: AMS 100-39 (PDKV Amba)	2239	2414	2557	2403	2855	2815	3040	2903
V4: JS 93-05	1921	1670	1737	1776	2394	2375	2474	2417
SE (m)+	64.27	63.04	66.95	52.05	83.28	71.99	86.09	57.91
CD at 5 %	188.48	184.86	196.34	152.66	244.21	211.10	252.46	169.85
Factor B: Seed rate								
S1: 50 kgha^{-1}	2016	2088	2186	2053	2337	2388	2508	2411
S2: 62.5 kg a^{-1}	2216	2210	2334	2296	2704	2641	2796	2713
S3: 75 kgha^{-1}	1990	1902	2020	1970	2874	2799	2997	2892
SE (m)+	55.66	54.59	57.98	45.08	72.12	62.34	74.56	50.15
CD at 5 %	163.23	160.09	170.03	132.21	211.49	182.82	218.64	147.09
Interaction								
SE (m)+	111.32	109.19	115.97	90.15	144.24	124.69	149.11	100.30
CD at 5 %	326.45	320.18	340.06	264.42	422.99	365.64	437.27	294.19
CV%	9.30	9.15	9.21	12.20	9.47	8.28	9.33	10.91
Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig

Seed yield (kg ha^{-1}) was affected significantly due to interaction between variety and seedrate. Significantly highest seed yield recorded in V_3 x S_2 treatment combination (2769 kg ha^{-1}) over rest of the treatment combinations. Data further indicated that the treatment combination V_1 x S_2 (2195 kg ha^{-1}), V_2 x S_2 (2392 kgha^{-1}), V_3 x S_2 (2769 kg ha^{-1}) and V_4xS_3 (1830 kgha^{-1}) recorded higher seed yield as compare to other treatment combinations.

Optimum seed rate is most important for the maximum yield of the crop. If more seed rate is used, the plant population will be more and there will be competition among plants for water, nutrient and sunlight resulting in low quality and low yield. Under lower plant population, radiation and light penetration over the canopy is efficient, leading to higher radiation use, photochemical reaction, photosyntheticrate, chloroplast development, Rubisco counter per area leading to efficient expression of seed yield. Several studies on Soybean indicated that a decrease in plant density produce greater growth of the individual plant {Epler and Staggenborg (2008) [7], Cox *et al.* (2010) [4] and Du Luca and Hungaria (2014)} [5] and consequently more leaf area, branches, pods and seeds per plant {Egli *et al.* (1987) [6], Lee *et al.* (2008) [17] and Cox *et al.* (2010)} [4]

Different varieties showed significant differences in yield attributes of different varieties. Rani *et al.* [2008] [25], Ali *et al.* [2013] [1] also concluded similar results in their experiments.

The increases in grain yield due to optimum seed rate have also been reported by Kumar and Badiyala [2005] [16], Patel and Varshney [2007] [21], Thoke *et al.* [2022] [31], Lone *et al.* [2010] [18] and Singh *et al.* [2012] [29]. Grain yield was positively related with plant height, primary and secondary branches, total dry matter and number of pods per plant. Varieties play an important role in determining the yield of a crop. The potential yield of variety within its genetic limit is set by environment. Islam *et al.* [2008] [13] also reported a significant genotypic difference with respect to morphological, physiological, phonological characters and yield and yield components.

Table 8: Seed yield (kg/ha) of soybean as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	2134	2281	2241	1558
S2	2195	2392	2769	1830
S3	1800	1940	2201	1941
SE (m) ±	90.15			
CD at 5%	264.42			

Straw yield (kg ha^{-1})

Pooled results indicated that higher straw yield was produced in treatment V_3 AMS 100-39 (PDKV Amba) (2903 kgha^{-1}) over the treatment V_1 AMS 1001(PDKV Yellow Gold) (2621 kgha^{-1}) and V_4 (2417 kgha^{-1}) but found at par with treatment V_2 AMS-MB 5-18 (Suvarn Soya) (2747 kgha^{-1}).

Seed rate 75 kgha^{-1} recorded significantly higher straw yield (2892 kgha^{-1}) over seed rate 50 kgha^{-1} (2411 kgha^{-1}) and 62.5 kgha^{-1} (2411 kgha^{-1}) in pooled data.

Straw yield (kg ha^{-1}) was affected significantly due to interaction between variety and seedrate. Significantly highest straw yield produced in V_3 x S_3 treatment combination (3266 kg ha^{-1}) over rest of the treatment combinations but at par with treatment combination V_3 x S_2 (2972 kg ha^{-1}).

Table 9: Straw yield (kg/ha) of soybean as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	2537	2588	2470	2047
S2	2624	2809	2972	2447
S3	2702	2843	3266	2758
SE (m) ±	100.30			
CD at 5%	294.19			

Economics

Gross monetary returns (Rs/ha) over the three years revealed that, significantly highest gross monetary returns was recorded by treatment V_3 (AMS 100-39 (PDKV Amba) (101748 Rsha^{-1}) as compared to rest of the treatments. Seedrate 62.5 kgha^{-1} recorded significantly higher gross monetary returns (96941 Rsha^{-1}) over seedrate 75 kg ha^{-1} (84013 Rs ha^{-1}) and seedrate 50 kg ha^{-1} (86901Rs ha^{-1}).

Table 10: Gross and net monetary returns (Rs ha^{-1}) of soybean as influenced by varieties and seedrate

Treatments	Gross monetary returns (Rs ha^{-1})				Cost of Production (Rsha^{-1})	Net monetary returns (Rs ha^{-1})			
	2020-21	2021-22	2022-23	Pooled Mean		2020-21	2021-22	2022-23	Pooled Mean
Factor A: Varieties									
V1: AMS 1001 (PDKV Yellow Gold)	81780	83197	94951	86642	40719	43140	43667	50963	45923
V2: AMS-MB 5-18 (Suvarn Soya)	86635	89883	103659	93392	40850	47995	50353	59277	52541
V3: AMS 100-39 (PDKV Amba)	91165	99575	114507	101748	41014	52525	60045	69633	60734
V4: JS 93-05	78134	69536	78407	75358	40468	39494	30006	35173	34890
SE (m)±	2501	2476	2884	2124	----	2501	2476	2750	2070
CD at 5 %	7336	7263	8458	6232	----	7336	7263	8066	6071
Factor B: Seed rate									
S1: 50 kgha^{-1}	81822	86051	97742	86901	39767	44182	47521	54611	47246
S2: 62.5 kgha^{-1}	90121	91257	104538	96941	40865	51481	51727	60111	55964
S3: 75 kgha^{-1}	81342	79334	91363	84013	41656	41702	38804	46562	42356
SE (m)±	2166	2145	2498	1840	----	2166	2145	2382	1792
CD at 5 %	6353	6290	7325	5397	----	6353	6290	6985	5258
Interaction									
SE (m)+	4333	4290	4996	3680	----	4333	4290	4764	3585
CD at 5 %	12707	12580	14651	10795	----	12707	12580	13971	10516
CV%	8.89	8.69	8.84	11.76	----	16.39	16.15	15.35	20.27
Test	Sig	Sig	Sig	Sig	----	Sig	Sig	Sig	Sig

Gross monetary returns (Rsha^{-1}) was influenced significantly due to interaction between variety and seedrate. Significantly highest gross monetary returns was noted in V_3xS_2 treatment combination (116670 Rsha^{-1}) over rest of the treatment combinations. Treatment combination V_1xS_2 (92709 Rsha^{-1}), V_2xS_2 (100801 Rsha^{-1}) and V_4xS_3 (82562 Rsha^{-1}) showed numerically highest gross monetary returns as compare to other treatment combinations.

Table 14: Gross monetary returns (Rsha^{-1}) of soybean as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	90373	96590	94717	65927
S2	92709	100801	116670	77587
S3	76845	82785	93860	82562
SE (m) ±	3680			
CD at 5%	10795			

Net monetary returns (Rsha^{-1})

In pooled results same trend was observed as that of gross monetary returns. Significantly highest net monetary returns was recorded in treatment V_3 AMS 100-39 (PDKV Amba) (60734 Rsha^{-1}) over all other treatments. Treatment S_2 (62.5 kgha^{-1}) recorded significantly highest net monetary returns (55964 Rsha^{-1}) over seedrate 75 kgha^{-1} (42356 Rsha^{-1}) and seedrate 50 kgha^{-1} (47246 Rsha^{-1}).

Net monetary returns (Rsha^{-1}) was influenced significantly due to interaction between variety and seedrate. Significantly highest net monetary returns was recorded in V_3xS_2 treatment combination (75413 Rsha^{-1}) over rest of the treatment combinations. Treatment combination V_1xS_2 (51917 Rsha^{-1}), V_2xS_2 (59449 Rsha^{-1}) and V_4xS_3 (40963 Rsha^{-1}) numerically showed highest net monetary returns as compare to other treatment combinations.

Table 16: Net monetary returns (Rsha^{-1}) of soybean as influenced by variety x seedrate interaction

Treatment	V1	V2	V3	V4
S1	50555	57063	54734	26629
S2	51917	59449	75413	37080
S3	35297	41112	52052	40963
SE (m) ±	3585			
CD at 5%	10516			

Benefit: Cost ratio

Over the three years pooled data revealed that, variety AMS 100-39 (PDKV Amba) (V_3) exhibited highest benefit: cost ratio (2.48) whereas lowest benefit: cost ratio was recorded in variety JS 93-05 (1.86). Seedrate 62.5 kgha^{-1} (S_2) showed higher benefit: cost ratio (2.37) over treatment S_1 and S_2.

Table 17: B:C Ratio of soybean as influenced by varieties and seedrate

Treatments	2020-21	2021-22	2022-23	Mean
Factor A: Varieties				
V1: AMS 1001 (PDKV Yellow Gold)	2.12	2.11	2.16	2.13
V2: AMS-MB 5-18 (Suvarn Soya)	2.25	2.28	2.34	2.29
V3: AMS 100-39 (PDKV Amba)	2.36	2.52	2.55	2.48
V4: JS 93-05	2.02	1.76	1.81	1.86
SE (m)±	---	---	---	---
CD at 5 %	---	---	---	---
Factor B: **Seed rate**				
S1: 50 kgha^{-1}	2.17	2.23	2.26	2.22
S2: 62.5 kgha^{-1}	2.33	2.31	2.47	2.37
S3: 75 kgha^{-1}	2.05	1.96	2.04	2.02
SE (m)±	---	---	---	---
CD at 5 %	---	---	---	---
Interaction				
SE (m)+	---	---	---	---
CD at 5 %	---	---	---	---
Test	---	---	---	---

Conclusion

From pooled data over the three years revealed that, variety AMS 100-39 (PDKV Amba) (V_3) showed significantly superior over rest of the varieties in respect of seed yield (2403 kg ha^{-1}), straw yield (2903 kg ha^{-1}) and also recorded higher gross monetary returns (101748 Rs ha^{-1}), net monetary returns (60734 Rs ha^{-1}) and B:C ratio (2.48). Seedrate 62.5 kgha^{-1} (S_2) was found significantly superior over all other seedrate i.e. seedrate 50 kgha^{-1} and seedrate 75 kgha^{-1} in respect of seed yield (2296 kg ha^{-1}), gross monetary returns (Rs.96941 ha^{-1}), net monetary returns (55964 Rsha^{-1}) and B:C ratio (2.37). Pooled results revealed that in variety x seedrate interaction, variety AMS 1001 (PDKV Yellow Gold), AMS-MB 5-18 (Suvarn Soya) and AMS 100-39 (PDKV Amba) recorded higher seed yield, straw yield, gross monetary returns and net monetary returns with seedrate 62.5 kgha^{-1}. Considering all above facts, for getting higher yield and monetary returns, sowing of soybean varieties PDKV Yellow gold, Suvarn soya and PDKV Amba with seedrate of 62.5 kgha^{-1} (minimum 70 % germination) is recommended.

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