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Growth and yield analysis of berseem (*Trifolium alexandrinum* L.) genotypes under different cutting management practices in Chhattisgarh plains

Rahul Kumar Jaiswal, SK Jha, DK Chandrakar and Anjali Patel

Abstract
A field experiment was laid out during the winter season of 2019 at 2020-21 and 2021-22 at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh to study the effect of cutting management practices on growth and yield of different berseem varieties. The experiment comprised five varieties *viz.*, JB-1, JB-5, BB-2, BB-3 and Wardan and four cutting management practices *viz.*, one cut at 60 DAS + seed (last cut at 15th January), two cut at 60 and 90 DAS + seed (last cut at 15th February), three cut at 60, 90 and 120 DAS + seed (last cut at 15th March) and no cut seed to seed were arranged in split plot design and replicated trice. The result showed that various growth parameters like dry weight of plant, number of tillers plant^{-1} and number of nodules plant^{-1}found higher in variety JB-1, while some parameter *viz.*, fresh weight of plant and leaf: stem ratio were found to be best in variety JB-5. Growth parameters *viz.*, plant height, number of leaves plant^{-1} were found to be performed best in no cut treatment, fresh and dry weight were recorded higher under one cut while number of tillers plant^{-1} and number of nodules plant^{-1} were found superior with two cut treatment. Most of the yield parameters were found to be performed as best in variety JB-1 and when crop is grown only for seed purpose. Significantly the highest total green fodder yield (243.9 q ha^{-1}), seed (4.83 q ha^{-1}) and straw yield (47.10 q ha^{-1}) was recorded with variety JB-1 over other varieties. Regarding number of cuts the highest total green fodder yield (384.0 q ha^{-1}) was produced from three fodder cut along with seed production while the seed (6.94 q ha^{-1}) and straw yields (69.47 q ha^{-1}) were recorded the maximum under no cut, where only seed production was taken. The highest fodder yield (392.4 q ha^{-1}) was produced from the combination of berseem variety Wardan X three cut while the seed (7.36 q ha^{-1}) and straw yields (69.47 q ha^{-1}) of berseem were produced from the variety JB-1 when no cut was made for fodder.

Keywords: Berseem, cutting, fodder yield, interactions, variety

Introduction
Berseem (*Trifolium alexandrinum* L.) is one of the most important leguminous forages in the Mediterranean region and in the Middle-East. It is a fast-growing high quality forage mainly cut and fed as green chopped forage. The berseem fodder is highly palatable due to its succulence and is also highly nutritious having 20% crude protein and 62% total digestible nutrients, 35- 38% acid detergent fiber, 24- 25% cellulose and 7- 10% hemicelluloses which increases the milching capacity of livestock. It is mostly grown as multipurpose crop such as for hay, forage and grains, with the grains often stored for planting next year (Dost *et al*., 2014) [4]. Cutting is very important practice for increasing the forage as well as seed yield of berseem (Mukherjee and Mandal, 2000) [9] due to the extra ordinary regenerative power and gives several cuttings during its growing season. However, delay in foliage cutting time may decrease seed yield and quality of the berseem, as very little time is available for seed setting. Low seed yields are also due to the lack of proper cutting management of foliage. All these factors lead to acute shortage of the seed of berseem. So, an understanding of optimum date of last foliage cut is essential for quality seed production. New varieties are also needed to assess for high seed production under Chhattisgarh condition to the short for a berseem seed in the state and this is why we can find out the way to reduce the dependency of better seed from Egypt and other countries. Therefore, in this present study we are going to validate the fodder and seed production technology of different cultivars with cutting management practices for Chhattisgarh state. This study may help seed producing agencies, state fodder seed production chain and framers towards self-sufficiency on berseem.

Material and Methods

An experiment was laid out for two consecutive season of *Rabi* during 2020-21 and 2021-22 at Instructional cum research farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh, situated in 21º16' N latitude, 81º36' E longitudes and 298 m mean sea-level). The experimental soil was clayey (*Vertisols*) locally known as *Kanhar*, neutral reaction (pH 7.0 low available nitrogen (150.52 kg ha^{-1}), medium available phosphorous (16.22 kg ha^{-1}) and high exchangeable potassium (363 kg ha^{-1}). The experiment was laid out in split plot design (SPD) with 3 repetitions. The treatment comprised five varieties *viz.* V_1: JB-1 (Jawahar Berseem-1), V_2: JB-5 (Jawahar Berseem-5), V_3: BB-2 (Bundel Berseem-2), V_4: BB-3 (Bundel Berseem–3), V_5: Wardan, arranged in main plot and four cutting management *viz.*,C_1: one cut at 60 DAS + seed (last cut at 15th January), C_2: Two cut at 60 and 90 DAS + seed (last cut at 15th February), C_3: Three cut at 60, 90 and 120 DAS + seed (last cut at 15th March and C_4: No cut seed to seed were taken as subplot treatments. Sowing was done manually by using 25 kg seed ha^{-1} by maintaining 30 cm row to row spacing and recommended dose of fertilizer of 20:60:40 N: P_2O_5: K_2O kg ha^{-1} was applied as basal. First cut was taken at 60 days after sowing and subsequent cuts were done at 30 days interval as per the treatments of berseem varieties. Influence of mentioned treatments on varieties was studied for growth behavior, yield attributes, fodder and seed yields of berseem cultivation and were computed and analyzed statistically using *F*- test, the procedure given by Gomez and Gomez (1984). Critical difference (CD) values at *P*=0.05 were used to determine the significance of mean differences of treatments.

Results and Discussion

The results of experiment regarding the response of varieties and cutting management toward the overall performance of berseem varieties revealed that various growth parameters like fresh weight (36.23 g $plant^{-1}$), dry weight (10.09 g $plant^{-1}$), number of tillers $plant^{-1}$ (5.98) and number of nodules $plant^{-1}$ (39.13) were recorded maximum in variety JB-1. Growth parameters *viz.*, plant height (88.12 cm), number of leaves $plant^{-1}$ (149.54) were found to be performed best in no cut treatment, fresh and dry weight (46.55 and 11.75 g $plant^{-1}$, respectively) were recorded higher under one cut while number of tillers $plant^{-1}$ (6.17) and number of nodules $plant^{-1}$ (43.32) were found superior with two cut treatment (Table 1). The differences in growth characters due to varieties may be attributed to their inherent characteristics. Devi and Satpal, 2019 [2] and Gaballah, 2006 [5] also described the same. A significant variation in plant height, fresh weight, dry weight and number of leaves were observed when different cutting managements were practiced might be attributed to the availability of more vegetative period which ultimately enhanced the growth parameters. These results corroborate the findings of Dhaliwal, 1979 [3] and Bhullar, 1975 [1].

The total green fodder yield of all cuts was recorded the maximum under variety Wardan (257.4 q ha^{-1}) during the year 2020-21 while in the year 2021-22 and in mean highest green fodder yield was noted under variety JB-1 (233.0 and 243.9 q ha^{-1} respectively). While the highest total green fodder yield was produced from three cut *i.e.* 384.0 q ha^{-1}. However, total green fodder yield recorded significantly maximum due to interactions of variety Wardan with three cut (392.4 q ha^{-1}) (Table 1). Godara *et al.*, 2016 [6] and Devi and Satpal, 2019 [2] also reported genotypic variations among genotypes for fodder yields and quality. Total green and dry fodder yields consistently increased with each delay in last cut for fodder from January to March might be owing to prolonged period for vegetative growth, enhanced growth rate, which resulted in more number of fodder cuttings. Nandanwar *et al.* (1990) [11] also reported higher yields of berseem with more number of cuttings. Increase in fodder yield with delay in last cut of fodder was due to prolonged period of vegetative growth (Surinder *et al.*, 2019) [15]. Musa *et al.*, 2021 [10] also reported similar results.

Yield attributing parameters like head length, head diameter, head weight, number of heads $plant^{-1}$ and weight of seeds $head^{-1}$ was recorded maximum with variety JB-1 among cutting management no cut seed to seed treatment produced maximum yield attributes (Table 1 and 2). Findings of Puri *et al.* (2007) [12] also supported these results. The reduction in number of heads m^{-2}, heads $plant^{-1}$, head weight, head length, head weight, 1000-seed weight in March cuts can be attributed to enhance in temperature and reduction in availability of nutrients. These explanations were supported by Musa *et al.*, 2021 [10].

Significantly highest seed yield of berseem was recorded with variety JB-1 (4.83 q ha^{-1}), which was found at par with varieties BB-2 (4.76 q ha^{-1}) and BB-3 (4.65 q ha^{-1}) on basis of two year mean. In regard to cutting management significantly maximum seed yield (6.94 q ha^{-1}) was recorded with no cut seed to seed treatment which was significantly superior over other cutting management treatments however the lowest seed yield (0.97 q ha^{-1}) was recorded with three cuts followed by seed production while last cut was done at 15th March. Significantly higher seed yield was produced by the combination of variety JB-1 with no cut (7.36 q ha^{-1}) which was found at par with the treatment combinations of JB-5 (7.07 q ha^{-1}), BB-3 (7.00 q ha^{-1}) and BB-2 (6.96 q ha^{-1}) with no cut, variety JB-1 (6.92 q ha^{-1}) and BB-2 (6.77) with one cut at 60 days after sowing (Last cut 15 January) followed by seed production (Table 2 and 3). Maximum straw yield was recorded with variety JB-1 (47.10 q ha^{-1}) in mean while the lowest was recorded with variety Wardan (40.64 q ha^{-1}). However, significantly the maximum straw yield (69.47 q ha^{-1}) was recorded with no cut over rest of the cutting management practices. Variety BB-2 recorded significantly the highest harvest index followed by varieties BB-3, JB-1 and JB-5. One cut with seed harvest gave significantly higher harvest index being followed by no cut and two cut (Table 2). Shrivastava, 2016 observed that the Wardan variety of berseem had shown drastic reduction in seed yield with the delaying in the date of last foliage cut as compared to variety Mescavi. Similar observation was reported by Kiyothong *et al.*, 2005 [8] in *S. guianensis* and Singh, 2014 in coriander. The low seed yields with delay in last cutting might be attributed to poor regeneration, shorter span for vegetative and reproductive phases, coincidence of pollination and fertilization phase with high temperature resulting in poor fertilization, embryo abortion and forced maturity. Surinder *et al.*, 2019 [15] believed that fewer fodder cuttings resulted in higher seed yield owing to the availability of food reserves for regeneration and seed development. Taneja *et al.* (1990) [16] also obtained similar results.

Table 1: Growth parameters (at harvest), green fodder yield and head length of berseem as influenced by different varieties and cutting management practices

Treatment	Growth parameters																		Yield attributes					
	Plant height (cm)			Fresh wt. (g plant^{-1})			Dry wt. (g plant^{-1})			Tillers plant^{-1}			Leaves plant^{-1}			Nodules plant^{-1}			Fodder yield (q ha^{-1})			Head length (cm)		
	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean
Varieties																								
JB-1	73.57	72.08	72.82	34.01	38.45	36.23	9.22	11.00	10.09	5.81	6.16	5.98	108.9	105.2	109.7	39.82	38.45	39.13	254.9	233.0	243.9	3.24	2.93	3.09
JB-5	69.80	72.61	71.21	32.48	37.39	34.94	9.64	9.95	9.80	5.27	5.61	5.44	117.7	109.5	112.2	39.55	38.63	39.09	242.5	229.4	235.9	2.87	2.76	2.82
BB-2	73.25	73.40	73.33	31.15	34.58	32.86	8.79	10.24	9.52	5.70	5.76	5.73	105.2	101.3	104.8	40.10	37.60	38.85	229.5	222.7	226.1	3.03	2.76	2.89
BB-3	74.09	74.05	74.07	29.64	36.51	33.08	7.89	9.69	8.79	5.11	5.45	5.28	125.9	108.7	113.6	39.35	37.92	38.63	244.6	232.3	238.5	2.73	2.83	2.78
Wardan	68.69	71.53	70.11	28.09	36.23	32.16	8.81	9.64	9.22	4.87	5.34	5.11	109.3	105.9	110.2	37.63	38.00	37.81	257.4	229.3	243.3	2.57	2.52	2.54
SEm±	1.69	1.19	1.01	1.00	0.70	0.59	0.31	0.28	0.23	0.19	0.15	0.16	4.41	3.16	2.30	0.65	0.77	0.52				0.09	0.04	0.05
CD (*P*=0.05)	NS	NS	NS	3.27	2.29	1.92	1.02	0.92	0.75	0.62	0.50	0.51	NS	NS	NS	NS	NS	NS				0.28	0.13	0.17
Cutting management practices																								
One cut	78.20	77.55	77.87	41.70	51.40	46.55	11.76	11.77	11.75	5.99	6.32	6.16	144.9	149.1	147.8	43.15	42.61	42.88	78.8	87.8	83.3	2.89	3.04	2.96
Two cuts	66.09	68.14	67.11	32.80	35.49	34.15	10.78	10.30	10.54	6.00	6.34	6.17	103.7	103.5	103.5	43.51	43.13	43.32	258.5	232.2	245.4	2.80	2.72	2.76
Three cuts	55.07	57.17	56.12	9.75	10.90	10.32	4.73	4.65	4.69	4.54	4.88	4.71	35.5	42.8	39.5	30.06	25.21	27.64	400.1	367.9	384.0	2.70	2.08	2.39
No cut seed to seed	88.17	88.08	88.12	40.05	48.73	44.39	8.20	13.70	10.95	4.88	5.11	5.00	169.5	129.1	149.5	40.43	41.52	40.97	-	-	-	3.16	3.20	3.18
SEm±	1.82	1.08	1.12	1.05	0.65	0.54	0.42	0.30	0.27	0.24	0.21	0.21	4.50	3.69	2.27	0.90	0.60	0.64				0.080	0.05	0.05
CD (*P*=0.05)	5.25	3.11	3.23	3.04	1.87	1.57	1.22	0.87	0.79	0.68	0.59	0.60	13.00	10.66	6.56	2.61	1.73	1.85				0.230	0.15	0.14
Interaction (VxC)																								
SEm±	3.90	2.40	2.39	2.27	1.44	1.21	0.88	0.65	0.58	0.50	0.43	0.43	9.77	7.82	4.96	1.87	1.39	1.34				0.176	0.11	0.11
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	1.70	NS	NS	NS	NS	NS	NS	NS	NS	NS				NS	NS	NS

Table 2: Yield attributes and yields of berseem as influenced by different varieties and cutting management practices

Treatment	Yield attributes															Yields of berseem								
	Head diameter (cm)			Head wt. (g)			Heads plant^{-1}			Seed wt. head^{-1} (g)			1000 grain wt. (g)			Seed yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index (%)		
	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean	20-21	21-22	Mean
Varieties																								
JB-1	1.13	1.02	1.08	0.34	0.37	0.36	6.27	5.28	5.78	0.27	0.30	0.28	2.77	2.68	2.73	4.50	5.16	4.83	43.44	50.76	47.10	9.00	9.12	9.06
JB-5	1.00	0.95	0.97	0.28	0.31	0.30	5.12	4.45	4.79	0.23	0.26	0.25	2.59	2.51	2.55	3.94	4.82	4.38	40.72	49.80	45.26	8.69	9.11	8.90
BB-2	1.04	1.00	1.02	0.31	0.34	0.32	5.65	4.88	5.27	0.27	0.30	0.29	2.73	2.64	2.68	4.34	5.17	4.76	40.52	49.26	44.89	9.47	9.59	9.53
BB-3	1.07	0.99	1.03	0.30	0.33	0.32	5.36	4.63	5.00	0.23	0.26	0.25	2.63	2.63	2.63	4.49	4.81	4.65	43.80	48.64	46.22	9.00	9.19	9.10
Wardan	0.97	0.91	0.94	0.25	0.28	0.27	4.92	4.15	4.54	0.22	0.25	0.24	2.33	2.38	2.35	3.43	4.08	3.76	36.05	45.24	40.64	8.49	8.15	8.32
SEm±	0.03	0.02	0.02	0.01	0.01	0.01	0.17	0.06	0.08	0.01	0.01	0.01	0.10	0.07	0.06	0.18	0.09	0.09	1.39	1.06	0.99	0.41	0.19	0.19
CD (*P*=0.05)	0.09	0.07	0.07	0.04	0.03	0.04	0.56	0.20	0.27	0.02	0.02	0.02	NS	NS	0.19	0.60	0.28	0.29	4.54	3.44	3.23	NS	0.61	0.63
Cutting management practices																								
One cut	1.01	1.02	1.06	0.33	0.40	0.37	6.02	5.01	5.51	0.26	0.30	0.28	2.85	2.88	2.86	5.22	6.55	5.89	51.70	63.97	57.83	9.31	9.28	9.30
Two cuts	1.00	0.96	0.98	0.28	0.30	0.29	5.44	4.40	4.92	0.24	0.27	0.26	2.56	2.46	2.51	3.91	4.30	4.10	39.09	42.73	40.91	9.17	9.17	9.17
Three cuts	0.96	0.83	0.89	0.20	0.17	0.19	4.01	3.84	3.93	0.19	0.22	0.20	2.03	1.99	2.01	1.13	0.82	0.97	13.91	8.25	11.08	7.54	8.99	8.26
No cut seed to seed	1.11	1.10	1.10	0.38	0.42	0.40	6.38	5.47	5.93	0.29	0.32	0.30	3.00	2.95	2.98	6.31	7.57	6.94	58.93	80.01	69.47	9.71	8.69	9.20
SEm±	0.025	0.02	0.02	0.017	0.01	0.01	0.19	0.07	0.09	0.01	0.01	0.01	0.07	0.08	0.05	0.13	0.09	0.09	1.11	1.30	0.95	0.26	0.25	0.22
CD (*P*=0.05)	0.072	0.07	0.05	0.050	0.04	0.04	0.56	0.19	0.25	0.02	0.02	0.02	0.19	0.22	0.13	0.37	0.27	0.25	3.22	3.74	2.76	0.75	NS	0.63
Interaction (VxC)																								
SEm±	0.055	0.05	0.04	0.036	0.03	0.03	0.41	0.14	0.19	0.01	0.01	0.01	0.16	0.16	0.11	0.31	0.20	0.19	2.57	2.72	2.10	0.65	0.52	0.47
CD (*P*=0.05)	NS	NS	0.12	NS	NS	NS	NS	0.43	0.55	0.04	0.04	0.04	NS	NS	0.32	0.94	0.59	0.56	NS	NS	NS	NS	NS	NS

Table 3: Interaction effect of different berseem varieties and cutting management practices on seed yield (q ha^{-1}) of berseem

Treatment	Number of cuts (C)											
	2020-21				2021-22				Mean			
Varieties (V)	One cut	Two cuts	Three cuts	No cut seed to seed	One cut	Two cuts	Three cuts	No cut seed to seed	One cut	Two cuts	Three cuts	No cut seed to seed
JB-1	6.26	3.77	1.07	6.89	7.57	4.32	0.93	7.82	6.92	4.05	1.00	7.36
JB-5	4.40	3.72	1.23	6.42	6.41	4.22	0.94	7.73	5.40	3.97	1.08	7.07
BB-2	6.13	3.90	1.29	6.06	7.41	4.63	0.78	7.87	6.77	4.27	1.03	6.96
BB-3	5.34	4.77	1.18	6.68	6.67	4.46	0.79	7.32	6.01	4.62	0.98	7.00
Wardan	3.98	3.37	0.90	5.49	4.71	3.88	0.64	7.11	4.34	3.62	0.77	6.30
	Two sub plots at the same main plot		Two main plots at the same or different sub plot		Two sub plots at the same main plot		Two main plots at the same or different sub plot		Two sub plots at the same main plot		Two main plots at the same or different sub plot	
SEm±	0.31		0.29		0.20		0.21		0.19		0.20	
CD (*P*=0.05)	0.94		0.83		0.59		0.60		0.56		0.59	

Conclusion

Yield of berseem production on the basis of two year of experiments variety JB-1, when one cut was taken at 60 days after sowing and left for seed production found to be optimum to produce highest seed yield to maximize economic returns.

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