Research Article

Apposite Sowing Techniques to Optimize Productivity and Profitability of Berseem

Muhammad Riaz Gondal[1]*, Sultan Ahmad Rizvi[1], Aaqib Riaz[2], Waqas Naseem[1], Ghulam Muhammad[1], Mazher Iqbal[3], Humara Umer[3] and Inam ul Haq[3]

[1]Soil and Water Conservation Research Institute, Chakwal, Pakistan; [2]Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan; [3]Barani Agricultural Research Institute, Chakwal, Pakistan.

Abstract | Berseem (*Trifolium alexandrinum L.*) is an important fodder crop of Pakistan that provides nutritious and palatable fodder in repeated cuttings. Gap in its yield is required to be addressed, which is aim of the current study. This study was carried out to select an appropriate sowing technique for optimization of fodder and seed yield as well as to maximize the net return. The experiment was conducted using five sowing techniques viz., broadcast, different row sowing with spacing of 15 cm, 30 cm, 45 cm and 60 cm. Sowing was done during first week of October during each year using seed of new berseem cultivar "Punjab Berseem" at rate of 20 kg ha^{-1}. All fodder parameters of each of four cuts and seed yield on harvesting were recorded and analyzed. The results showed that broadcast (BC) sowing gave maximum values of yield attributes and increased fodder yield by 43.78 %; seed yield by 14.18 % and CP yield by 45.14% over control (i.e., row spacing of 30 cm). Economic analysis indicated a maximum benefit-cast ratio of 3.51 under broadcast sowing in standing water as compared to control.

Received | September 30, 2020; **Accepted** | December 08, 2020; **Published** | March 03, 2021
***Correspondence** | Muhammad Riaz Gondal, Soil and Water Conservation Research Institute, Chakwal, Pakistan; **Email:** riazgondal1962@gmail.com
Citation | Gondal, M.R., S.A. Rizvi, A. Riaz, W. Naseem, G. Muhammad, M. Iqbal, H. Umer and I. Haq. 2021. Apposite sowing techniques to optimize productivity and profitability of berseem. *Pakistan Journal of Agricultural Research,* 34(1): 128-135.
DOI | http://dx.doi.org/10.17582/journal.pjar/2021/34.1.128.135
Keywords | Broadcast sowing, Fodder yield, Seed production, Yield optimization

Introduction

Agriculture sector plays a pivotal role in the economic growth of Pakistan. Presently, it contributes 19 % to gross domestic product (GDP) and provides employment to 42% of the labor force. It is also one of the biggest sectors for earning of foreign exchange and excites the growth of several of other sectors (GoP, 2018). Pakistan's agriculture sectors are expanding with the recent emergence of other allied sectors, amongst livestock sector is one of the biggest of these sectors. It is obvious that with a dwindling natural resource base coupled with climate change scenario, the yield potential of crops will be adversely affected due to a direct effect on rainfall patterns and distribution. Hence, judicious use of the limited water resources is imperative to enhance the production of fodder and other agronomic crops (Farooq *et al.*, 2019). This calls for adoption of such techniques, which optimize the water use.

Huge deficit in demand and domestic production of green fodder exists that need to be abridged to cope with demand of fast-growing livestock sector. Livestock being an essentials agriculture allied sector shares around 11 % in GDP, which is 60.54 % of agriculture contribution to GDP (GoP, 2019). Due to shortage as well as unavailability of good quality

fodder, animals remain under nourished resulted in low production. Unawareness of farmers about high yielding fodder cultivars, proper crop stands, unavailability of quality seed, lack of adaption of improved production technologies are the core limitations responsible for low yield of fodder in Pakistan (FRI, 2018-19). The significant gap between demand and production of fodder couples with the adaptation of proper cultivation techniques to overcome this gap. Cultivation of high yielding cultivars under improved sowing techniques can maximize fodder production (Nawaz, 2017). Planting techniques affects the plant stand, root development and growth of plants by modulating the inter-plant competition, spatial distribution of plants and acquisition of resources (Dabhi, 2017; Shahzad *et al*., 2016). Choubey *et al*. (1991) studied the effect of cultivation methods on forage yield and seed production of berseem, and indicated that the broadcast (BC) method gave maximum fresh fodder and dry matter (DM). Berseem is the main cultivated legume fodder in south east Asia because of its more vegetative growth, multi-cut nature, better forage output after harvesting, prolonged time of forage provision, prominent fodder yield with outstanding delicious and excessive beneficial value with crude protein contents (20-21 %) and 62 % of total edible food (Yadav *et al*., 2015). It is known as "king of fodders "due to its highest tonnage capacity among fodders. It has no toxic effects. It is mainly used as green fodder during its active season and as hay and pallets during the off-season (Nigam *et al*., 2010). Cultivation of berseem in Rabi season has the potential to supply fresh fodder uninterruptedly for entire rabi season and early summer. In Pakistan, a large number of Livestock needs constant supply of fresh forage. Due to the extra ordinary regenerative power, berseem gives several cuttings during its active season and supply nutritious, palatable and succulent forage for animals (Gul *et al*., 2006). Normally 4-6 cuttings of berseem are taken in Pakistan (Graves, 1996) however, it is capable of 5-7 cuts of succulent forage (Khan *et al*., 2012). Low fodder production and less feed availability are the major limiting factors for increasing livestock productivity in Pakistan. Improvement in livestock production depends on the availability of proper quality and quantity of feed (Amanullah *et al*., 2005). In green fresh form, Berseem contains about 10 % total digestible nutrients (TDN), 2.2 % digestible crude protein (DCP) and is rich in protein composing 23 % of the biomass on a dry matter basis (Randhawa *et al*., 2009). (Ahmed *et al*., 1991) reported that DM in berseem remained low (10.2 %) in young and reached more than 20 % at third cut. Sowing techniques play the main role in yield increase of berseem. Dabhi, 2017 also reported that BC method produced maximum green and dry matter yield. Singh *et al*. (2019) reported that maximum fodder yield in berseem was achieved when sown by broadcast method till 15th November. Garza and Marquez, 1994 reported that improvement in seed yield required proper and efficient method of planting. Quite rare work has been carried out on testing and evaluation of sowing techniques for fodder yield enhancement. Keeping in view the fodder shortage in the country and reviewing the earlier work carried out by limited number of researchers, the present investigation was planned to determine the effect of sowing techniques on fodder and seed yield as well as net return of berseem crop.

Materials and Methods

Experimental site

The field investigation was conducted during Rabi seasons of 2015-6, 2016-7 and 2017-8 at the farm area of Fodder Research Institute Sargodha (32.45040 N, 72.68610 E, altitude 155 m) Pakistan. The average seasonal rainfall of the area was recorded as 390 mm in 2016, 410 mm in 2017 and 430 mm in 2018. Soil of Sargodha was loam having pH 7.8±0.11, K+174 ±6.34 mg kg^{-1}, N %, 0.06 ±0.01, P 5.6 ±0.41 and organic matter 0.61 % (Niazi *et al*., 2020). The soil properties were determined adopting the standard procedure.

Experimental layout

The experiment consisted of five sowing techniques viz., Broadcast (SM 1), drilling with row spacing of 15 cm apart (SM2), 30 cm apart (SM3), 45 cm apart (SM4) and 60 cm apart (SM5). Field was prepared by two ploughing with planking followed by one ploughing with rotavator then applied pre-sowing irrigations except broadcast method plots. After that when soil reached to appropriate moisture level, uniform seed bed for sowing was prepared. Randomized complete block design (RCBD) with split plot arrangements, having four replications was used with net plot size of 6.0 m ×3.6 m for each treatment. Sowing was done during first week of October each year using 20 kg ha^{-1} seed of new berseem cultivar "Punjab Berseem". In treatments

of broadcast technology, seed was broadcasted uniformly in standing water and other all treatments (SM2, SM3, SM4, SM5) were sown with hand drill according to the requirement of treatments in wattar condition on the same day. Fertilizer comprising 57-57-57 kg ha^{-1} NPK was applied in all treatments. Of which total P, K and half nitrogen was applied at seed bed preparation and remaining half of nitrogen was applied after 25 days of sowing (DAS).

Crop harvesting and data collection

First cut of fodder was obtained from BC method after 55 days of sowing when crop achieved 55-60 cm height and second cut of SM1 and first cut of all other sowing techniques (SM2, SM3, SM4, SM5) was taken after 90 days of sowing after achieving 55–60 cm height by crop. All other subsequent cuttings were taken when crop achieved proper stage for cutting. The crop was left for seed production on 31st March of each year after taking four cuts (C1, C2, C3, C4) as fodder. After each cut, fresh fodder yield per plot was taken in field by using spring balance, which was converted into fodder yield per hectare. Growth attributes such as plant height and tillers per square meter were recorded before harvesting of crop. Plant height of twelve randomly selected plants of each plot was recorded from the land surface to base of upper youngest leaf on stem with meter ruler. Tillers from three square meter, randomly selected with the help of one square meter quadrate in each plot were counted and averaged. For estimation of dry matter (DM) yield, dry matter percentage was determined by weighing fresh and oven dried samples. Entire plots of each treatment were harvested and thrashed on maturity of crop. Seed yield was obtained by recording 1000-grain weight averaged from three samples under each treatment.

Net return

Net Return was calculated by subtracting the total of various costs (namely, the tillage, fuel, labor, seed ect.) involved in cultivation of fodder per individual treatment from gross income estimated as per prevailing market selling rates of fresh fodder and seed.

Quality analysis

The dried samples were grinded and passed through mesh sieve #40 for quality estimations. Crude protein (CP) was determined by using procedure of (Chemists, 1990). CP percentage was calculated by multiplying the N % determined by Kjeldahl method with a factor 6.25.

Statistical analysis

All the data gathered were subjected to statistical analysis by following Fisher's analysis of variance method (Steel, 1997). Means were compared with LSD test at 5 % probability level as described by (Gomez and Gomez, 1984).

Results and Discussion

The results showed significant differences among sowing techniques for all cuts of fodder and post-harvest observations after maturity of crop for seed. During entire study period comprising three years, same trends were observed in all sowing techniques and growth attributes. Broadcast technique produced higher forage and dry matter yield than rows spacing methods during experimental years 2016, 2017 and 2018 (Table 1). The highest fresh fodder yield (91.62 tons –ha^{-1}) was obtained from BC technique and lowest forage yield (45.9 tons-ha^{-1}) was obtained by SM5. Profitable berseem production is contingent upon establishment of a dense vigorous stand, because berseem field remain productive for 7 to 8 months. Poor stand establishment can reduce the economic value of berseem by decreasing yield, and reducing the quality values of hay. Schmierer *et al.* (1997) reported that poor stand establishment of alfalfa, reduced profitability by decreasing yield and nutritional quality of hay. By broadcasting, berseem seed distributes uniformly leaving no part without seed as the case of row sowing where space in between row remains empty thus gives maximum germination percentage per unit area. Mustafa, 1996 reported that alfalfa plants density increased during count before harvest when sown on ridges by broadcasting seed. Considering the forage yield of cuts, the highest mean value (24.63, and 24.12 tons-ha^{-1}) was observed in 2nd and 3rd cuts of BC technique and all other treatments provided higher yield of fresh fodder except at 3rd cut (Table 2). Regarding fodder yield, BC technique produced maximum green and dry herbage yield as compared to rows methods (Dabhi, 2017, Gaballah, 2006). El-Debaby *et al.* (1994) also reported that sowing of crop by BC method produced taller plants than rows sowing method. Broadcasting is faster and seed is distributing uniformly as compared to rows sowing (Schmierer *et al.*, 1997). Observing the yearly averages of all methods, the 3rd cut gave

significantly highest fresh fodder yield (19.455 tons-ha^{-1}) and minimum (10.16 tons-ha^{-1}) was obtained in 1st cut. Similarly, the highest dry matter yield was obtained from broadcast method during three years field investigation (Table 1). Maximum dry matter yield (12.79, 13.95, 13.96 and 13.57 tons-ha^{-1}) was observed under broadcast method during 2016, 2017, 2018 and minimum dry matter yield of 6.89, 6.44, 7.04 and 6.79 tons ha^{-1} was obtained from broadcast method in 2016, 2017, 2018 considering the means of years respectively. Average of all sowing techniques showed maximum dry matter (2.884 tons-ha^{-1}) at 3rd cut and minimum (1.51 tons-ha^{-1}) at first cut (Table 1). Considering the dry matter yield of cuts×SM, the highest value (3.653 tons-ha^{-1}) was obtained by BC at 2nd cut and minimum (0.85 tons-ha^{-1}) by SM5 at 1st cut (Table 2). However, Elhag (2007) reported contrary results. He found significant differences for overall means of alfalfa fresh fodder and dry matter weight among sowing techniques in different cuts.

Table 1: *Berseem fresh and dry matter yield as effected by sowing method.*

Treatment	Fresh fodder yield (t/ha)				Dry matter yield			
SM/CUTS	2016	2017	2018	Means	2016	2017	2018	Means
SM 1	85.27 a	92. 89 a	96.70 a	91.622 a	12.796 a	13.950 a	13.960 a	13.569
SM 2	56.33 b	65.19 b	69.625 b	63.718 b	8.450 b	9.778 b	10.098 b	9.441 b
SM 3	53.26 c	57.31 c	61.500 c	57.359 c	7.991 c	8.605 c	8.921 c	8.505 c
SM 4	48.96 d	45. 29 d	49.569 d	47.941 d	7.346 d	6.788 d	7.186 d	7.106 d
SM 5	45.90 e	42. 94 d	48.500d	45.778 e	6.887 e	6.442 e	7.035 d	6.789 e
LSD	1.516	1.9171	3.0148	1.7336	0.2278	0.2986	0.4181	0.2532
C 1	8.44 d	10.714 d	11.316 d	10.158 d	1.2671 d	1.6086 d	1.6414 d	1.5057 d
C 2	11.609 c	13.455 c	14.701 c	13.255 c	1.7420 c	2.0179 c	2.1324 c	1.9641 c
C 3	19.505 a	18.797 a	20.061 a	19.455 a	2.9256 a	2.8304 a	2.8963 a	2.8841 a
C4	18.392 b	17.758 b	19.100 b	18.417 b	2.7591 b	2.6559 b	2.7699 b	2.7283 b
LSD	0.0674	0.2235	0.1219	0.0933	0.0096	0.0301	0.0315	0.0124

Table 2: *Berseem fresh fodder and dry matter yield as effected by cuts × SM.*

Treatment	Fresh forage yield				Dry matter yield (t/ha)			
Cuts×SM	2016	2017	2018	Means	2016	2017	2018	Means
C 1×SM 1	17.987 g	20.848 c	22.081 b	20.305 c	2.7012 g	3.1269 c	3.202 b	3.0100 c
C 1×SM 2	7.625 jk	12.548 i	11.281 h	10.485h	1.1437	1.8819 j	1.6363 h	1.5540 h
C 1×SM 3	6.831 lm	7.950 l	9.313 i	8.031 i	1.0250 lm	1.1925 m	1.3513 i	1.1896 i
C 1×SM 4	5.242 n	6.789 m	6.781 j	6.271 j	0.7869 n	1.0187 n	0.9838 j	0.9298 j
C 1×SM 5	4.525 n	5.438 n	7.125 j	5.696 j	0.6788 n	0.8231 o	1.0338 j	0.8452 j
C 2×SM 1	23.388 a	25.037 a	25.475 a	24.633 a	3.5087 a	3.7544a	3.694 a	3.6525 a
C 2×SM 2	13.583 i	13.775 h	15.345 ef	14.234 g	2.0375 i	2.0663 i	2.2256 ef	2.1098 g
C 2×SM 3	7.832 j	10.423 j	13.219 g	10.491 h	1.1750 j	1.5631 k	1.9175 g	1.5519 h
C 2×SM 4	7.054 kl	9.243 k	9.844 i	8.713 i	1.0587 kl	1.3863 l	1.4281 i	1.2910 i
C 2×SM 5	6.188 m	8.796 kl	9.625 i	8.203 i	0.9300 m	1.3194 lm	1.3962 i	1.2152 i
C 3×SM 1	22.575 b	24.872 a	24.925 a	24.124 a	3.3869 b	3.7313 a	3.551 a	3.5567a
C 3×SM 2	18.064 g	20.074 cd	21.781 b	19.973 c	2.7094 g	3.0106 cd	3.158 b	2.9596 c
C 3×SM 3	19.831 d	19.831 de	19.781 c	19.815 c	2.9750 d	2.9831 de	2.869 c	2.9425 c
C 3×SM 4	18.929 e	14.748 g	16.694 de	16.790 e	2.8382 e	2.2062 gh	2.4175 d	2.4873 e
C 3×SM 5	18.125 fg	14.467 gh	17.125 d	16.572 e	2.7188 fg	2.2206g	2.4837 d	2.4744 e
C 4×SM 1	21.325 c	22.138 b	24.219 a	22.560 b	3.1994 c	3.3375 b	3.512 a	3.3496 b
C 4×SM 2	17.063 h	18.799 f	21.219 b	19.027 d	2.5594 h	2.8194 f	3.077 b	2.8287 d
C 4×SM 3	18.769 ef	19.110 ef	19.188 c	19.022 d	2.8156 ef	2.8663 ef	2.7825 c	2.8215 d
C 4×SM 4	17.742 gh	14.509 gh	16.250 de	16.167 ef	2.6619 gh	2.1769 ghi	2.3562 de	2.3983 e
C 4×SM 5	17.063 h	14.238 gh	14.625 f	15.308 f	2.5594 h	2.0794 hi	2.1213 f	2.2533 f
LSD	0.6816	0.8857	1.3537	0.7809	0.1023	0.1368	0.1896	0.1143

Table 3: *Berseem plants height and tillers as effected by sowing method.*

Treatment	Plants height (cm)				Tillers /m²			
SM/CUTS	2016	2017	2018	Means	2016	2017	2018	Means
SM 1	72.50 a	77.95 a	78.98 a	76.47 a	425.0 a	495.0 a	525.4 a	481.8 a
SM 2	70.52 b	73.51 b	76.65 a	72.81 b	282.5 b	287.5 b	288.7 b	286.3 b
SM 3	67.37 c	71.25 c	73.68 b	71.52 c	246.9 c	261.2 c	267.1 c	258.4 c
SM 4	62.06 d	65.70 d	67.81 c	65.14 d	224.4 d	220.5 d	217.5 d	220.6 d
SM 5	61.08 e	65.51 d	67.66 c	64.80 d	223.7 d	202.7 e	182.1 e	203.1 e
LSD	0.8845	0.6912	2.4841	0.8707	16.85	11.59	12.56	9.52
C 1	49.00 d	52.20 d	54.36 d	51.85 d	180.8 d	191.2 d	196.1 d	189.4 d
C 2	64.64 c	68.81 c	69.98 c	67.81 c	238.9 c	248.8 c	253.0 c	246.9 c
C 3	75.32 b	79.33 b	82.24 b	78.96 b	338.5 b	355.5 b	357.8 b	350.6 b
C4	77.86 a	82.80 a	85.25 a	81.97 a	363.7 a	378.2 a	377.8 a	373.2 a
LSD	0.5998	0.9194	2.2755	0.6941	8.805	15.45	13.55	7.33

Table 4: *Berseem plant height and tillers as effected by cuts ×SM.*

Treatment	Plant height (cm)				Tillers /m²			
Cuts ×SM	2016	2017	2018	Means	2016	2017	2018	Means
C 1×SM 1	55.50 l	60.75 j	63.63 h	59.96 l	380.0 c	450.0 c	513.7 b	447.9 c
C 1×SM 2	54.50 l	50.00 l	58.50 i	54.34 m	136.3 jk	141.3 l	143.0 i	140.2 lm
C 1×SM 3	47.50 m	56.50 k	51.92 j	52.98 n	127.5 k	142.5 l	142.0 i	137.3 m
C 1×SM 4	45.00 n	47.00 m	49.00 j	47.00 o	122.7 k	117.7 m	108.0 j	116.2 n
C 1×SM 5	42.52 o	46.75 m	48.75 j	46.01 o	137.7 jk	104.3 m	73.50 k	105.2 n
C 2×SM 1	78.60 d	82.60 c	78.90 ef	80.03 cd	456.3 a	526.3 a	560.0 a	514.2 a
C 2×SM 2	67.60 i	61.20 j	76.20 fg	68.33 i	230.0 h	135.0 j	238.0 g	234.3 j
C 2×SM 3	57.40 k	72.65 f	63.20 hi	64.42 j	169.5 i	182.0 k	192.0 h	181.2 k
C 2×SM 4	60.60 j	64.60 h	66.60 h	63.93 Jk	160.9 ij	157.3 l	150.0 i	156.0 l
C 2×SM 5	59.00 jk	63.00 i	65.00 h	62.33 k	178.3 i	143.7 l	125.0 ij	149.0 lm
C 3×SM 1	84.40 b	90.25 a	93.00 ab	89.22 a	440.0 ab	510.0 ab	520.0 b	490.0 b
C 3×SM 2	77.50 d	82.60 c	83.60 cde	81.23 c	390.0 c	395.0 d	401.0 c	395.3 d
C 3×SM 3	78.20 d	70.60 de	85.60 bc	81.13 c	356.7 cd	369.3 ef	374.3 d	366.7 ef
C 3×SM 4	67.00 i	71.00 g	73.00 g	70.33 h	323.7 de	320.3 g	312.0 e	318.6 g
C 3×SM 5	69.50 h	73.20 f	76.00 fg	72.90 g	308.0 ef	296.3 h	282.0 f	295.4 h
C 4×SM 1	71.50 g	78.20 e	80.40 ef	76.70 f	423.7 b	493.7 b	508.0 b	475.2 b
C 4×SM 2	82.50 c	91.20 a	88.30 bc	87.33 b	373.7 c	378.7 de	373.0 d	375.2 e
C 4×SM 3	86.40 a	85.30 b	94.00 a	88.56 ab	333.7 de	351.3 f	360.0 d	348.3 f
C 4×SM 4	75.62 e	80.20 d	82.05 de	79.29 de	287.7 fg	286.7 hi	300.0 ef	291.5 h
C 4×SM 5	73.30 f	79.10 de	81.50 de	77.96 ef	273.7 g	266.7 i	248.0 g	262.8 i
LSD	1.691	1.5385	4.9871	1.7037	31.39	25.82	26.22	18.54

Regarding growth attributes, BC sowing technique produced highest number of tillers per square meter and maximum plant height (Table 3). Maximum number of tillers to the tune of 425, 495, 525 and 482 m^{-2} were observed in BC sowing while the minimum number of tillers to the tune of 224, 203, 182 and 203 m^{-2} were observed in row sowing with 60 cm apart rows. This could possibly be attributed to the favorable mutual shading among plants as well as no empty space was left for weed plants those more likely were observed in row sowing where empty space among rows provided space and favorably environment to grow weeds and compete the berseem plants. In row sowing, spaces in rows might have had given weeds better chances to grow and shared berseem plants in nutrients and moisture. Considering the number of

tillers of the cuts, the maximum number of tillers (364, 378, 378 and 373 m^{-2}) were found in 3rd cut during the years 2016, 2017, 2018 and their means, respectively. Elhag (2007) reported maximum plant height, plant population, leaf to stem ratio, fresh fodder (tons-ha^{-1}), dry weight (tons-ha^{-1}) in alfalfa sown on ridges by broadcasting seed. Considering cut×SM, BC sowing method produced highest number of tillers of 514 m^{-2} at 2nd cut and lowest number of tillers of 140 m^{-2} in row sowing (SM2) at 1st cut (Table 4). Similarly, the maximum plant height was recorded in BC sowing technique and lowest in row sowing with 60 cm apart rows (Table 3). Maximum plant height to the tune of 72.50, 82.80, 78.98, and 76.47 cm was recorded in broadcast cultivation during study period (2016, 2017, 2018 respectively and minimum plant heights of 49.0, 65.51, 67.81 and 64.8 cm were obderved in SM5 during three years and their mean. Comparing the plant heights of cuts, maximum plant height (81.97 cm) mean of three years was observed at 4th cut and lowest (51.85 cm) at 1st cut (Table 3). Interactive effects of cuts×SM showed positive behavior on plant height (Table 4). BC sowing gave the maximum plant height (89.21 cm) at 3rd cut and minimum (59.95 cm) at 1st cut while all other SMs indicated maximum plant height at 4th cut. The differences in crude protein yield were found to be significant, greatest crude protein yield (2.54 tons-ha^{-1}) was given by broadcast method and minimum (1.3 tons-ha^{-1}) from SM5. Considering the crude protein yield of individual cuts, maximum crude protein yield (0.5057 tons-ha^{-1}) was observed in 4th cut and minimum (0.2797 tons-ha^{-1}) at 1st cut (Table 5). El-Debaby *et al.* (1994) found that broadcast sowing provides taller plants as compared with row spacing in Egyptian clover crop. Interactive effect of cuts×SM also showed positive response to CP, maximum CP yield (0.6840 tons-ha^{-1}) was obtained at 2nd cut by broadcast method and minimum (0.5633 tons-ha^{-1}) at 1st cut (Table 6). The maximum seed yield (0.845, 0.812 tons-ha^{-1}) was noted from SM1 and SM2 respectively and minimum (0.662 tons-ha^{-1}) from SM5. Maximum 1000-seed weight (2.53 gm) was observed in SM5 and minimum (2.07 gm) in SM2 and same trends was observed throughout study periods. Furthermore, Berseem plants in the broadcasting method produced a greater number of heads m^{-2}, with heavier 1000-seed weight and hence seed yield as compared to row sowing one (Table 7). Arora *et al.* (1998) reported that maximum seed yield was achieved from BC sowing technique as compared to row sowing.

Table 5: *Berseem crude protein yield as effected by sowing method.*

Treatment	Crude protein yield			
SM/CUTS	2016	2017	2018	Means
SM 1	2.43 a	2.58 a	2.611 a	2.5413 a
SM 2	1.59 b	1.79 b	1.879 b	1.7538 b
SM 3	1.49 c	1.58 c	1.650 c	1.5756 c
SM 4	1.37 d	1.235 d	1.320 d	1.3075 d
SM 5	1.27 e	1.166 e	1.295 d	1.2463 e
LSD	0.0428	0.0273	0.0774	0.0476
C 1	0.2390 d	0.2955 d	0.3046 d	0.2797 d
C 2	0.3275 c	0.3703 c	0.3958 c	0.3645 c
C 3	0.5480 a	0.5187 a	0.5370 a	0.5346 a
C4	0.5169 b	0.4866 b	0.5136 b	0.5057 b
LSD	0.0018	0.00539	0.0058	0.00233

Table 6: *Berseem crude protein yield as effected by cuts × SM.*

Treatment	Crude protein yield tones/ha			
Cuts ×SM	2016	2017	2019	Means
C 1×SM 1	0.51 ef	0.58 c	0.59 b	0.56 c
C 1×SM 2	0.22 i	0.34 h	0.30 h	0.29 h
C 1×SM 3	0.19 j	0.22 k	0.25 i	0.22 i
C 1×SM 4	0.15 l	0.18 l	0.18 j	0.17 j
C 1×SM 5	0.12 l	0.15 m	0.19 j	0.15 j
C 2×SM 1	0.67 a	0.69 a	0.69 a	0.68 a
C 2×SM 2	0.38 h	0.38 fg	0.41 ef	0.39 g
C 2×SM 3	0.22 i	0.28 i	0.35 g	0.29 h
C 2× SM 4	0.20 j	0.25 j	0.26 i	0.24 i
C 2×SM 5	0.17 k	0.24 jk	0.26 i	0.22 i
C 3×SM 1	0.64 b	0.69 a	0.66 a	0.67 a
C 3×SM 2	0.51 ef	0.55 d	0.59 b	0.55 c
C 3×SM 3	0.56 d	0.55 d	0.53 c	0.54 c
C 3×SM 4	0.53 e	0.40 fg	0.44 de	0.46 e
C 3×SM 5	0.50 f	0.40 f	0.46 d	0.45 e
C 4×SM 1	0.61 c	0.62 b	0.66 a	0.63 b
C 4×SM 2	0.48 g	0.51 e	0.57 b	0.52 d
C 4×SM 3	0.53 e	0.53 de	0.51 c	0.52 d
C 4×SM 4	0.49 fg	0.40 fg	0.43 de	0.44 e
C 4×SM 5	0.47 g	0.38 g	0.39 fg	0.41 f
LSD	0.0292	0.0252	0.031	0.0212

Economic analysis

The economic analysis, carried out on the basis of fresh fodder and seed yield revealed that berseem crop sown under broadcast sowing gave maximum net return of Rs. 283,250 ha^{-1} followed by drill sowing at 15 cm apart rows (Rs. 203,825). Benefit- cast ratio

for broadcast sowing was the highest (3.51) followed by drill sowing 15 cm apart rows (Table 8). Maximum benefit cost ratio recorded from BC method was due to high yield of fodder and seed as compared to drill sowing method (Hussain *et al*., 2015).

Table 7: *Berseem seed yield and 1000-seed weight as effected by sowing method.*

Treatment	Seed yield t/ha				Thousands grain weight (grams)			
SM	2016	2017	2018	Means	2016	2017	2018	Means
SM 1	0.61a	0.96a	0.97a	0.84a	2.00d	2.12d	2.10d	2.07d
SM 2	0.59a	0.92a	0.92a	0.81a	2.00d	2.12d	2.10d	2.07d
SM 3	0.53b	0.84b	0.84b	0.74b	2.13c	2.25c	2.23c	2. 20c
SM4	0.48c	0.83bc	0.79b	0.70c	2.33b	2.45b	2.43b	2.40b
SM 5	0.41d	0.79c	0.79b	0.66d	2.46a	2.58a	2.56a	2.53a
LSD	0.034	0.052	0.069	0.043	0.124	0.128	0.123	0.123

Table 8: *Economic comparison of different sowing techniques.*

SM	Cost of cultivation	Fodder income Rs/ha	Seed income Rs/ha	Total income Rs/ha	Net return Rs/ha	Benefit cast ratio
SM1	113,000	213,250	183,000	396,250	283,250	3.51
SM2	111,000	140,825	174,000	314,825	203,825	2.84
SM3	110,700	133,500	153,000	286,500	175,800	2.59
SM4	110,300	122,425	144,000	266,425	156,125	2.42
SM5	110,000	114,750	123,000	237,750	127,750	2.16

Conclusions and Recommendations

Conclusively, results indicated that Punjab Berseem cultivar when sown by broadcast method in standing water and left for seed production on 31st March after taking 5 cuts as fodder, produces maximum fodder, seed and CP yield and also provides maximum net return as compared to the drill sowing.

Novelty Statement

Berseem is an important fodder crop of Pakistan, which is widely used for feeding livestock. Emerging sector of livestock requires more fodder. In climate of Pakistan no remarkable work has been carried out on testing sowing methods so the current study is totally a novel study of its type, in which line sowing has been compared with the broadcasting method. This study revealed that broadcast sowing of berseem in standing water gives best fodder and seed yield.

Author's Contributions

Muhammad Riaz Gondal: Conceptualizing, Planning and execution of the study along with data collection and drafting the text.
Sultan Ahmad Rizvi: Reviewing the draft, writing the abstract, evaluating the results, Manuscript setting after refining the article to its final shape.
Aaqib Riaz: Collection, recording, arranging the data with preliminary analysis.
Waqas Naseem: Analyzing the data, preparing and setting of tables, reviewing the literature.
Ghulam Muhammad: Drafting the introduction and typing the draft of manuscript.
Mazher Iqbal: Technical input for overall management and correction of article.
Humara Umer and Inam ul Haq: Setting of tables and references.
All Authors have read the manuscript and approved for publication.

Conflict of interest
The authors have declared no conflict of interest.

References

Ahmed, A., M. Mousa, M. Ahmed and M. Beshay. 1991. Chemical evaluation of berseem clover (The Egyptian cv Giza 10), Trifolium alexandrinum L., using different technique analysis. Zagazig J. Agric. Res. (Egypt).

Amanullah, A.K., S. Alam and H. Khan. 2005. Performance of berseem varieties at Peshawar. Sarhad J. Agric., 21(3): 317-321.

Arora, R.M., G.P. Lodhi, N.K. Thakral and Het-Ram. 1998. Effect of methods of sowing and seed rates on seed yield in berseem (*Trifolium alexandrinum* L.). Haryana Agric. Univ. India. J. Res., 28(2-3): 117-118.

Chemists, A.o.O.A., 1990. Methods of analysis, AOAC, The association.

Choubey, S., K. Prasad, R.K. Bhagat and V.C. Srivastava. 1991. Forage production and seed yield of berseem as influenced by methods of sowing and number of cuttings. J. of Res. Birsa. Agric. Univ., India.

Dabhi, M.S., 2017. Response of oat (*Avena sativa* L.) varieties to methods of sowing and nitrogen levels on forage yield and quality. (Ed. (Eds.), Dep. Agron. BA Coll. Agric. Agric. Sci.,

El-Debaby, A.E., F.E. Shafshaq, S.A. Scif and S.A.

Stethdham. 1994. Effect of sowing method and seeding rate on growth and yield of some berseem clo ver (*Trifolium alexdandrium* L) varieties Egypt. J. Appl. Sci., 9(6): 723-734.

Elhag, B.B.M.m 2007. Effects of sowing methods and potassium application on the performance of two Alfalfa cultivars (*Medicago sativa* L.).

Farooq, M., M. Hussain, S. Ul-Allah and K.H. Siddique. 2019. Physiological and agronomic approaches for improving water use efficiency in crop plants. Agric, Water Manage., 219: 95-108. https://doi.org/10.1016/j.agwat.2019.04.010

FRI (Fodder Research Institute), 2018. Annual Research progress for year 2018, Fodder Research Institute, Sargodha, Pakistan.

Gaballah, E.S., 2006. Effect of sowing method and cutting system on forage and seed production of some egyptian clover cultivars (*Trifolum alexandrinum* L.). J. Prod. Dev., 11(2): 279-295. https://doi.org/10.21608/jpd.2006.45319

Garza, H. and J. Marquez. 1994. Effect of dates, densities and methods of sowing on seed yield of berseem clover. J. Agric. Res., 90(3): 163-173.

Gomez, K.A. and A.A. Gomez. 1984. Statistical procedures for agricultural research, John Wiley and Sons.

GoP, 2018. Pakistan economic survey, economic advisor's wing, finance division. Government of Pakistan, Islamabad.

GoP, 2019. Pakistan economic survey, economic advisor's wing, finance division. Government of Pakistan, Islamabad.

Graves, W.L., 1996. Berseem clover: A winter annual forage for California agriculture, University of California, Communication Services Publications, DANR Publisher, USA. pp. 15-22

Gul, H., B. Saeed, A. Said, F. Mohammad and I. Ahmad. 2006. Influence of late planting dates and planting methods on seed production of clovers.

Hussain, M., M.M.Q. Baig, M.F. Iqbal and M. Qadir. 2015. Ridge sowing technique: A new crop establishment technique for wheat in rice-wheat cropping system of northern Punjab. Int. J. Adv. Multidiscip. Res., 2: 14–18.

Khan, I., A.U. Jan, I. Khan, K. Ali, D. Jan, S. Ali and M.N. Khan. 2012. Wheat and berseem cultivation: A comparison of profitability in district Peshawar. Sarhad J. Agric., 28(1): 83-88.

Mustafa, F., 1996. Effect of sowing methods and phosphorous application on performance of two alfalfa cultivars. M. Sc. (Agric.) thesis, University of Khartoum.

Nawaz, M.Q., 2017. Effect of different sowing methods and nitrogen levels on fodder yield of oat in salt affected soil. Pak. J. Agric. Res., 30(4). https://doi.org/10.17582/journal.pjar/2017/30.4.323.328

Niazi, I.A.K., S. Akhtar, S. Kohli, A. Naveed, S. Rauf and M. Shehzad. 2020. Oat (*Avena sativa* L.) advanced lines outperform existing cultivars for forage yield and its components under terminal heat stress. Pak. J. Agric. Sci., 57(2).

Nigam, P., R. Srivastava and N. Verma. 2010. Effect of different cuttings and growth retardant (cycocel) on higher forage yield and seed yield in berseem (*Trifolium alexandrinum* L.). Int. J. Plant Sci., (Muzaffarnagar), 5 (2): 660-663.

Randhawa, H.S., S.S. Aulakh, I. Bhagat and J.S. Chhina. 2009. Efficacy of different insecticides against Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae) on seed crop of berseem in Punjab. Legume Res. Int. J., 32(2): 145-148.

Schmierer, I.L., S.B. Orloff and R.W. Benton. 1997. Intermountain Alftlf" Management. University of California, Division of Agriculture and Natural Resources.

Shahzad, M., M. Farooq, K. Jabran and M. Hussain. 2016. Impact of different crop rotations and tillage systems on weed infestation and productivity of bread wheat. Crop Prot., 89: 161-169. https://doi.org/10.1016/j.cropro.2016.07.019

Singh, A., R. Sharma and A. Singh, 2019. Effect of date of sowing and cutting management on seed yield in berseem (*Trifolium alexandrinum* L.). J. Krishi Vigyan, 8(1): 96-100.

Steel, R.G., 1997. Pinciples and procedures of statistics a biometrical approach.

Yadav, P.S., D. Vijay and D. Malaviya. 2015. Effect of cutting management on seed yield and quality attributes of tetraploid berseem. Range Manag. Agrofor., 36(1): 47-51.