Research Article

Optimisation of Sowing Method for Seed Production in Berseem (*Trifolium alexandrinum*)

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Abstract | Berseem, a multi-cut fodder, is the best source of nutrition for animals. Seed is a key to get optimum yield of any crop. There are many factors affecting seed production but the sowing method is a major one. A study to assess the consequence of different sowing methods on seed production of berseem (SB-11) was directed at Fodder Research Institute, Sargodha, Pakistan during 2017-18 and 2018-19. Different sowing methods, broadcast and row spacing of 15cm, 30cm, 45cm, 60cm apart were used. Plant height (cm), number of capsules/m^2, number of seeds/capsule, 1000-grains weight (g) and seed yield (kg/ha) parameters were studied. It was observed that sowing methods had a significant outcome on seed yield. The results depicted that broadcast sowing gave maximum seed yield of 954 kg ha^{-1} while the lowest seed yield (789 kg ha^{-1}) was recorded in 60 cm row spacing sowing. In nut shell, broadcast method had the highest potential to achieve maximum seed yield in berseem clover. Appropriate sowing method is one of the important components in production technology of any crop. In Pakistan, at farmer level, berseem seed production is less because of non-availability of improved production technology and advance machinery. If results of the present study are made part of recommended production technology of berseem for farmers, it will enhance the seed production of berseem in Pakistan in future.

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Introduction

Berseem is an important fodder crop and commonly cultivated in south-east Asia. It has multiple benefits such more initial growth of vegetation, multi-cuttings, long term fodder provision, better forage productivity, and high nutritional value of 20-21% basic protein and 62% of palatable diet (Yadav *et al*., 2015). In Pakistan, berseem is cultivated as rabi fodder and it is considered as beneficial fodder and also it is cultivated on large scale in its growing season. Due to its high yielding nature, it is known as "king of fodders". Berseem fodder has no toxic effects and it is liked by animals for feeding. In off season it is used as hay or pallets and used as green forage during the season (Nigam *et al*., 2010). Almost 16 to 19% area is covered by fodder crops in Pakistan (Saeed *et al*., 2011).

There is substantial break between petition and production of fodder in Pakistan which can be cater through cultivation of high yielding fodder cultivars along with adaptation of proper production technology (Nawaz, 2017). Seed production of fodder crops in terms of quality and quantity is important for sustainable fodder production (Kamanzi and Mapiye,

2012). In central region of Pakistan, the sowing time of berseem is mostly end of September to November and after sowing its two to three or more multi-cuttings are taken till March, then the crop is allowed to complete its reproductive cycle for attaining the seed. Different factors like delay of last cutting, fluctuating temperature, low humidity, reduction of pollinators, poor cultural practices and severe pest attack are responsible for low seed production in berseem (Bakheit *et al*., 2012; Yadav *et al*., 2015; Asmaa *et al*., 2017; Singh *et al*., 2019). Recommended seed production technology of berseem is not being applied efficiently by the farmers due to which seed production and quality is very low. Plant stand, root and shoot development and plant growth by controlling the competition in between the plants longitudinal distribution of plants and achievement of resources are affected by different planting techniques (Dabhi, 2017; Shahzad *et al*., 2016). Planting techniques play crucial role in increase of berseem yield. It was reported by (Garza and Marquez, 1994) that upgrading in seed production could be attained by adopting proper and efficient method of planting. Berseem cultivation with broadcast sowing technique resulted in more yield as it gets more nutrition and water in bulk quantity as compared to sown in row spacing of different distances (Bakheit *et al*., 2012; El-Zanaty, 2005).

Different factors like insufficiency of normal seed (Tufail *et al*., 2019) or less awareness for advanced techniques of forage produce are responsible for low fodder production in developing countries like Pakistan (Kamanzi and Mapiye, 2012). During the year of 2014 about 30000 tons of seed was imported from abroad to fulfill the forage need in Pakistan (Farooq, 2015). Quality seed, appropriate sowing methods, timely sowing and harvesting are the chief contributing aspects for obtaining maximum seed production in berseem (Gondal *et al*., 2021a). Due to lack of awareness about improved seed production technology, average seed yield of berseem at farmer's field is very low in Pakistan. (Amato *et al*., 2013) also reported that less seed production is also mostly due to absence of knowledge about advanced knowledge for seed production under field environment. Optimization of sowing progression is an imperative part in standardization of berseem production expertise for particular variety to get maximum yield.

So having the consideration on the importance of right production technology, the study aimed to determine the most appropriate sowing method to achieve maximum seed yield in berseem clover.

Materials and methods

Experimental site

The two years (2017-18 and 2018-19) field experiment was directed at Fodder Research Institute, Sargodha, Punjab-Pakistan (32˚60'N; 72˚59'E; 189m above sea level). Soil samples were taken from the experimental plots before sowing and were analyzed from Soil & Water Testing Laboratory, Sargodha. The soil analysis report showed that soil texture was clay loam, electric conductivity (EC) value of 0.77 dS m^{-1}, pH 7.5, OM of 0.69%, available phosphorus and extractable potassium of 6.3 and 135 mg kg^{-1}, respectively during both years. Mean rainfall and average temperature are shown in Table 1.

Table 1: *Weather data recorded during the crop growth duration.*

Month	Average Maximum Temperature (°C)	Average Minimum Temperature (°C)	Rainfall (mm)
March-2018	30.71	16.12	0.00
April-2018	34.29	19.74	60.2
May-2018	38.27	25.91	19.7
June-2018	29.76	27.84	78.5
March-2019	25.12	12.92	24.7
April-2019	34.20	21.10	48.0
May-2019	37.61	23.43	49.2
June-2019	41.45	27.31	15.0

Experimental design and treatments

Seed of berseem advance line SB-11 was obtained from Fodder Research Institute, Sargodha. Five different sowing methods *i.e.,* Broadcast and line sowing with 15cm, 30cm, 45cm and 60cm apart. The design used for Randomized Complete Block Design having repetition four times. The net plot size was 6 m × 3 m (18 m^2).

Seed bed preparation and sowing

The soil was well managed for by using the rotavator. Two ploughings followed by planking were done. Crop was sown on 15 October and 20 October in 2017-18 and 2018-19, respectively. All other recommended cultural practices were carried out. Crop was harvested to obtain seed in first week of June and

threshing was done at proper time. Keeping in view soil analysis 1.25 bags/ha Urea, 3.75 bags/ha DAP (Diammonium phosphate), 2.5 bags SOP (Sulphate of Potash) were applied.

Data recording

After taking three fodder cuttings up to 31th march, the crop was left for seed productions. Data regarding different morphological traits (plant height, number of capsules per meter square and number of seeds per capsule) and yield related attributes (1000-grains weight and seed yield were recorded.

Plant Height: Data on plant height was measured in centimeter at blooming stage by using the measuring rod by selecting 5 plants per plot, and then average value was taken.

Number of Capsules/ m²: Value for Number of capsules per meter square was counted in 1 m^2 area at three different random places in a plot and then average value was calculated.

Number of seeds per capsule: Number of seeds were counted one by one by taking 5 capsules randomly and then average number of seed per capsule was calculated.

1000 grains weight (g): Five samples of seed were taken from the bulk then 1000-seed weight (TSW) was noted of each sample separately by using weighing balance and then average was taken.

Seed yield (kg ha^{-1})**:** The mature crop was harvested per plot to record the seed yield (kg) and afterword converted into kg ha^{-1}.

Statistical analysis

Two years pooled data were statistically analyzed by using software Statistix 8.1. At 5% probability level, LSD (least significant difference) test was used to calculate the means where ANOVA (analysis of variance) showed significant differences (Steel *et al.*, 1997).

Results and Discussion

Plant height

The analysis of variance (ANOVA) showed significant difference among various sowing methods for plant height (Table 2). The highest plant height (72.51 cm) was observed in broadcast method followed by 15 cm apart row spacing and lowest plant height (65.17 cm) was observed in 60cm apart row spacing during both years (Table 3).

Table 2: *Analysis of variance (ANOVA) on morphological traits and seed yield of berseem grown under different sowing methods (Average of two years).*

Source	Mean square					
	Df	Plant height (cm)	Number of capsules m^{-2}	Number of seeds $capsule^{-1}$	Seed yield (Kg ha^{-1})	1000-grains weight (g)
Replication	3	1.875	1.3	0.67	1.5	0.001
Sowing method	4	45.57**	43907.2**	22.80*	22426.8**	0.05**
Error	12	1.32	5.3	4	9.3	0.0012

Number of capsules

Maximum number of capsules m^{-2} were observed in broadcast method (457) and number of capsules / m^2 were lowest (202) in 60 cm row to row spacing during the respective years (Table 3).

Number of seeds per capsule

Observations showed that numbers of seeds per capsule were maximum in Broadcast method (44) and lowest seeds/capsule was found in 60cm Apart (38).

1000-grain weight

The ANOVA showed that 1000-grains weight was maximum in broadcast method which was at par with 15cm row spacing (2.64 g) while minimum 1000 grains weight was observed in 60cm row spacing (2.40 g).

Seed yield

The ANOVA showed that significant different among sowing methods (Table 2). The maximum seed yield (SY: 954 kg ha^{-1}) was recorded in broadcast method and minimum SY (789 kg ha^{-1}) was observed in 60 cm row spacing during both years (Table 3).

Seed production of fodder crops in term of quality and quantity is important for sustainable fodder production and continuous supply of feed stuff to the livestock (Paterson *et al.*, 1998). Seed production in forage crops are affected by various factors including unavailability of improved and hybrid seed, temperature fluctuation, untimely agronomical performs, less and

Table 3: *Morphological traits and seed yield of berseem grown under different sowing methods (Average of two years).*

Sowing methods	Plant height (cm)	Number of capsules m^{-2}	Number of seeds $capsule^{-1}$	Seed yield (Kg ha^{-1})	1000-grains weight (g)
Broadcast	72.5A	457A	44A	954A	2.64A
15cm Apart	71.2A	273B	43AB	924B	2.64A
30cm Apart	68.7B	257C	41ABC	841C	2.48B
45cm Apart	65.2C	203D	40BC	796D	2.44BC
60cm Apart	65.2C	202D	38C	789E	2.40C
LSD (p≤0.05)	1.77	3.56	3.08	4.70	*0.05*

untimely availability of farm inputs including absence of better-quality seed of best performed varieties at the farm level (Surinder *et al*., 2019; Anwar *et al*., 2012). Sowing date, sowing method, proper seed rate, last cutting date, availability of pollinators and insect pests management are the major factors which contribute to successful seed production in forage crops like berseem and alfalfa (Tufail *et al*., 2019; El-Zanaty, 2005). (Lewandowski *et al*., 2003; Ul-Allah *et al*., 2014) reported that proper sowing method is very important for multi cut forage crops. (Amato *et al*., 2013) also indicated that absence of latest and advanced technology for seed production is the main reason for low yield at farm level. (Singh *et al*., 2019) reported that broadcast is most efficient sowing method to get maximum yield in berseem. Therefore, the current experiment was designed to distinguish the best method of sowing for maximum seed production in berseem.

It is evident from the results that the differences among broadcast and row spacing sowing methods were significant in most of the tested attributes related to seed yield in berseem. (Gaballah, 2006) reported similar results that broadcast method produced taller plants as compared to rows method. (El-Debaby *et al*., 1994) also found that plants were significantly taller in broadcast sowing as compared to rows sowing method with different spacings. (El-Debaby *et al*., 1994) found similar results that manual broadcasting method gave significantly higher number of heads per plant in berseem clover. Contrary to these results, (Khair, 1999) also reported that sowing methods did not show significant effect on number of pods per plant in alfalfa. Number of pods per plant may be genetically an inherited trait. These consequences are similar with the conclusions of (Gaballah, 2006), who described that broadcast method produced heavier thousand grain weigh than the row spacing methods. Moreover, (Gondal *et al*., 2021b) also reported that broadcast method had significant effect 1000-grain weight as compared to row spacing one. (Gondal *et al*., 2021b; Gaballah, 2006; Arora *et al*., 1998) also described similar results and found that broadcast method produced significantly higher seed yield than the row sowing method. From the results of experiment, broadcasting method produced significantly higher morphological and yield related traits than the row sowing method with different spacing. (Gondal *et al*., 2021b; Gaballah, 2006) also reported similar results. It is noticed that broadcast method produced taller plants compared with row sowing method of berseem crop.

This might be credited to satisfactory common shielding among berseem plants and also having a more uniform distribution of these plants where the competition was in their favor against weeds. In row sowing method, row spacing could be better for weeds to grow and share berseem plants soil fertility and water (Gaballah, 2006). Conclusively, results indicated that broadcast method produced maximum seed yield for berseem advance line SB-11 under agro climatic condition of Sargodha.

Conclusion and Recommendations

It was concluded that berseem sown in 2nd week or 3rd week of October with broadcast method produce maximum seed yield, considering all other agronomic and plant protection measures as constant. This production qualified for accumulating of mineral nutrients, crucial elements, and suppression of weeds and appropriate method of sowing for seed production.

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Novelty Statement

Broadcast is the most efficient sowing method to obtain maximum seed production of berseem under agro-climatic condition of Punjab.

Author's Contribution

Abdul Jabbar: Planned and executed the trail.
Anees-Ul-Hussnain Shah: Recorded the data.
Abdul Basit: Wrote results and discussion.
Ghulam Ahmad: Wrote abstract and introduction.
Aftab Ahmad Khan: Reviewed literature cited.
Suleman Raza: Did statistical analysis of data.
Muhammad Sultan Ali Bazmi: Described methodology.
Imtiaz Akram Khan Niazi: Provided technical input in the study.
Ahmad Hussain: Reviewed the article.

Conflict of interest

The authors have declared no conflict of interest.

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