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Effect of Sowing Dates, Cutting Regimes and Nutritional Sprays at Reproductive Stage on Seed Yield and Quality of Berseem (*Trifolium alexandrinum* L.)

Avinash Karjule* and Vijay Shelar

Seed Technology Research Unit, MPKV, Rahuri, Ahmednagar, Maharashtra (413 722), India

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Corresponding Author

Avinash Karjule

e-mail: avinashkarjule@gmail.com

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Abstract

A field experiment was conducted in the field of Seed Technology Research Unit, MPKV, Rahuri during rabi season 2014-15 for the study of the effect of normal and late sowing, last cutting regimes and nutritional sprays at the time of flowering on the seed yield and quality attributes of Berseem (*Trifolium alexandrinum* L.). It was observed that the yield attributing characters *viz.,* number of flowers plant^{-1} (41), number of seeds flower^{-1} (52), seed yield plot^{-1} (226 g), seed yield ha^{-1} (1.34 q) and days to 50% flowering (116) were significantly superior at normal sowing time *i.e.* 15th October, and with the last cut 10 days before normal last cut *i.e.* 18th Feb. and nutritional sprays of KNO_3 @ 2% and Borax @ 100 ppm (separate spray) at the reproductive stage over the other treatment combinations. Similarly, seed quality parameters *viz.*, germination (94.00%) was significantly superior in the same treatment combination. For higher seed yield and quality seed production in Maharashtra sowing at normal sowing time *i.e.* 15th October last cut 10 days before normal last cut *i.e.* 18th Feb. and nutritional sprays of KNO_3 @ 2% and Borax @ 100 ppm (separate spray) at the reproductive stage.

1. Introduction

Berseem (*Trifolium alexandrinum* L.) is one of the most important *rabi* legume fodder crops and cultivated under irrigated conditions in India. Due to its very high green fodder producing capacity, berseem is also known as "king of fodders." It is best for animal feeding due to its anti-nutritional and toxic effects. The nutritional composition of berseem is 2.9% phosphorous, 18.3% protein, 2.6% calcium and 20 ppm carotenes and also rich source of vitamin A (Khalil, 2008). In India, it is mostly used as green forage, however during off season it is also used in the formation of hay and pallets *etc*. (Nigam *et al.,* 2010). During the growing season of 4-5 months Berseem has an advantage of multiple cuttings and the farmers might take 8-10 cuttings if the soils are enriched in organic matters and nutritional status. Farmer produces hay during off season and its quality mainly depends on maturity stage of the crop and its chemical composition.

Genetic variability of *Trifolium* spp. is low due to their narrow genetic base and hence it is low seed producers. Its vegetative and reproductive phases occur simultaneously leading to poor seed setting. Due to more cuttings very little time is available for seed setting. In case of late sowing the pollination and fertilization phases came across high air temperature and low relative humidity. The other reasons for lower seed setting in berseem are limited bee activity resulted in poor fertilization, pollen sterility and post-fertilization abortion of developing seeds.

Delayed sowing of berseem is mainly due to late harvesting of rice in most of the northern states of India. For better fodder and seed yield optimum sowing dates must be followed. Berseem sown from first week of September to first week of November is very helpful for dual benefit of the green fodder as well as seed production. The proper sowing time leads to benefit of favourable environmental conditions during growth and sufficient time will be available after fodder cutting for optimum vegetative growth, attainment of bloom, pollination and seed setting. Most of the farmers continued the fodder cutting till the mid April and after that the crop is retained for seed production. In such conditions there is very less foliage and during hot and dry summer climate the flowering and seed setting is very poor which leads to very less seed production and due to such negligence the farmers get very less benefit in seed production (El-nably *et al.*, 2012). Lack of interest and attention in seed production, temperature, relative humidity prevailing during the reproduction phases are the major factors for the shortage of good quality seeds in Berseem. High temperature during flowering stage, stimulates respiration and reducing photosynthesis (Hayat *et al.*, 2009). The last cut for fodder should be managed in such a way that blooming and seed development stages coincide with the favourable weather conditions which may be decided by manipulation

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of suitable date of sowing and last cut management.

The successful crop production depends mainly on the availability of the quality seed, which is one of the critical inputs for the agriculture. Quality seeds will enhance the yield and biomass. However; the seed yield of Berseem is comparatively low due to their excessive vegetative growth as well as reduced seed set. Indian farmers faces acute shortage of green fodder and non-availability of quality seeds is one of the key reason for such fodder shortage. At current situation the availability of quality seeds is approximately 30 percent in cultivated fodder crops. Due to lack of seed production and technological skills, the berseem seed producers could not get the optimum yield levels. Keeping the above view in consideration, the present study was undertaken to find out the effect of optimum and delayed sowing, the time of last cutting after which crop is retained for seed production and the beneficial effects nutritional spray at flowering stage on seed yield and quality of berseem.

2. Material and Methods

A field experiment was laid out in randomized complete block design with four repeats having a plot size of 16 m^2. The berseem variety Vardan was sown on two different sowing dates *i.e.* S_1: 15th October (Normal sowing) and S_2: 15th January (Late sowing). The first cut was given 60 days after sowing (DAS) and 2nd cuttings after 25 days interval after 1st cut. Normal last cut 25 DAS after 2nd cut *i.e.* 1st March. The 2nd cut was not taken in the late sowing (15th January) and the normal last cut was given on 1st March. For determination of last cut effect, two cutting regimes *i.e.* C_1: 10 days before normal last cut (18th Feb) and C_2:10 days after normal last cut (11th March) were undertaken. The separate nutritional sprays were given at the flowering stage *viz.,* N_1: No spray as a control and N_2: KNO_3 @ 2% and Borax @ 100 ppm (Separate spray). The plant growth observations, seed yield and seed quality parameters *viz.,* Germination (%), Seedling length (cm), Seedling dry weight (g) and vigour indices were recorded at the proper plant growth and after crop harvest. Seedling vigor indices were calculated by using formula suggested by Abdul-Baki & Anderson (1973). The Seedling vigor index = Standard germination (%) × Seedling dry weight (mg).

The recorded data were analyzed using standard method of Analysis for Variance (ANOVA) for three factor Randomized Block Design for field experiment as per Panse and Sukhatme (1985). The Least significant difference was noted at probability of less than 0.05.

3. Results and Discussion

3.1 Effect of Sowing Dates on Seed Yield and Quality

The seed yield and quality parameters were significantly influenced due to time of sowing (Table 1 and 2). Number

Table 1: Effects of sowing date, cutting regimes and nutritional spray on plant growth and seed yield parameters in berseem

Treatments	Days to 50% flowering*	No. of flowers/ plant	No. of florets per flower	No. of seeds/ flower	Length of inflorescence (cm)	Plant height (cm)	Ovule to seed ratio	Days to maturity*	Seed yield/ plot (g)	Seed yield (q/ha)
Sowing Date:										
S_1: Normal (15th Oct.)	32.06	29.79	59.35	40.08	2.06	51.39	1.48	71.81	181.88	1.134
S_2: Late (15th Jan.)	27.25	25.94	56.06	37.20	1.98	47.04	1.38	61.06	155.00	0.923
SE ±	0.334	0.578	0.956	0.786	0.057	1.155	0.051	0.313	2.481	0.019
CD at 5%	0.974	1.699	2.811	2.295	NS	3.371	NS	0.912	7.245	0.055
Cutting regimes:										
C_1: 10 days before normal last cut	29.38	33.06	63.14	43.31	2.15	54.07	1.54	66.75	183.56	1.228
C_2: 10 days after normal last cut	29.94	22.66	52.28	33.96	1.89	44.37	1.32	66.13	153.31	0.830
SE ±	0.334	0.578	0.956	0.786	0.057	1.155	0.051	0.313	2.481	0.019
CD at 5%	NS	1.699	2.811	2.295	0.166	3.371	0.149	NS	7.245	0.055
Nutritional spray at reproductive stage:										
N_1: No Spray	31.25	21.30	50.20	30.13	1.81	39.12	1.47	67.06	132.56	0.985
N_2: KNO_3 @ 2% and Borax @ 100 ppm	28.06	34.43	65.21	47.15	2.23	59.32	1.39	65.81	204.31	1.073
SE ±	0.334	0.578	0.956	0.786	0.057	1.155	0.051	0.313	2.481	0.019
CD at 5%	0.974	1.699	2.811	2.295	0.166	3.371	NS	0.912	7.245	0.055

*From last cut date

Table 2: Effects of sowing date, cutting regimes and nutritional spray on seed quality attributes in berseem

Treatments	1000 seed weight (g)	Germination (%)	Root shoot length (cm)	Vigour index I
Sowing Date:				
S_1: Normal (15th Oct.)	2.13	90.25	10.50	920.02
S_2: Late (15th Jan.)	2.10	87.50	10.17	877.32
SE ±	0.025	0.439	0.205	18.577
CD at 5%	NS	1.282	NS	NS
Cutting regimes:				
C_1: 10 days before normal last cut	2.17	90.62	10.88	962.86
C_2: 10 days after normal last cut	2.05	87.12	9.78	834.48
SE ±	0.025	0.439	0.205	18.577
CD at 5%	0.073	1.282	0.600	54.236
Nutritional spray at reproductive stage:				
N_1: No Spray	2.03	85.25	9.58	811.07
N_2: KNO_3 @ 2% and Borax @ 100 ppm	2.20	92.50	11.08	986.27
SE ±	0.025	0.439	0.205	18.577
CD at 5%	0.073	1.282	0.600	54.236

of flowers plant^{-1} (30), Number of florets flower^{-1} (59), Number of seeds flower^{-1} (40), seed yield plot^{-1} (182 g), seed yield ha^{-1} (1.13 q), Plant height (51.39 cm), and seed quality parameters *viz.,* germination (90.25%) were significantly superior in the normal sowing date *i.e.* 15th October than 15th January (Late sowing). However; days to 50% flowering (27), days to maturity (61) were significantly lower in 15th Jan sowing irrespective of cutting regimes and nutritional spray at the reproductive stage compare to late sowing. These results might be due to the large differences in climatic conditions prevailing in these planting dates. early sowing (10th November) produced taller plants and more number of branches plant^{-1} and increased vegetative growth of plant under favorable weather as a resulted more biological yield as compared to late sowing.

In late sowings, due to low air and soil temperatures, seed germination was delayed and reduced. Low air temperature during the early vegetative growth stage reduced the growth rate of plants and high temperature during later growth stages adversely affected regeneration after cutting. Usmani-Khalil *et al*. (2001) reported sowing berseem clover on the 15th of November gives more fresh forage and seed yields than sowing on the 1st December. The decrease in number of seeds per head with delayed sowing due to reduced growth period was observed by Din *et al.* (2014). Similar results were obtained by Sardana and Narwal (2000), El-Zanaty (2005), Ranjbar (2007), Gul *et al*. (2011), Din *et al.* (2015), Mohamed *et al*. and Mohar *et al*. (2017).

3.2 Effect of Cutting Regimes on Seed Yield and Quality

The seed yield and quality parameters were significantly influenced due to cutting regimes (Table 1 and 2). Number of flowers plant^{-1} (33), number of florets flower^{-1} (63), number of seeds flower^{-1} (43), length of inflorescence (2.15 cm), ovule to seed ratio (1.54), seed yield plot^{-1} (184 g/plot), seed yield ha^{-1} (1.23 q), 1000 seed weight (2.17 g), plant height (54.07 cm), and seed quality parameters *viz.,* germination (90.62%), root shoot length (10.88 cm), vigour index I (962.86) were significantly superior in 10 days before normal last cut over other cutting regime *i.e.* 10 days after normal last cut irrespective of sowing dates and nutritional spray at the reproductive stage. Days to 50% flowering and maturity was not influenced significantly. Cutting is very important practice for increasing the forage as well as seed yield of berseem and shaftal (Mukharjee and Mandal, 2000). Maximum seed yield might be due to the cumulative effect of physiologically younger plants and optimum exposure of growing period with favourable climatic conditions (Sardana and Narwal, 2000). Yadav *et al.* (2015) reported low seed yield with delayed date of last cut. Seed quality measured in terms of germination and vigour also decreased with delay in date of last cut. Higher seed yield attributes in 10 days before normal last cut indicating that by leaving the crop for sufficient vegetative growth will result in higher seed production. Delayed cutting resulted in seed yield reduction might be due to decrease in number of flowers per head, seed set per cent and 1000 seed weight. The seed setting is also greatly influenced by weather parameters like temperature and photoperiod. The higher temperatures decreased duration of vegetative and reproductive phases and pollinator movement. Similar findings of yield reduction due to delay in last cut were reported by several other workers (Sinha and Rai, 1995; Singh and Kang, 2004; Puri *et al*., 2007). The present data is in conformity with the findings of Kumar and Patel (2017), Surinder *et al.* (2019) and Singh *et al.* (2019).

3.3 Effect of Nutritional Spray at the Time of Reproductive Stage Seed Yield and Quality

The seed yield and quality parameters were significantly influenced due to nutritional spray of KNO_3 @ 2% and Borax @ 100 ppm (Separate spray) at the reproductive stage (Table 1 and 2). Number of flowers plant^{-1} (34), number of florets flower^{-1} (65), Number of seeds flower^{-1} (47), length of flower (2.23 cm), seed yield plot^{-1} (204 g), seed yield ha^{-1} (1.07 q), 1000 seed weight (2.20 g), Plant height (59.32 cm), days to 50% flowering (28), days to maturity (65) and seed quality parameters *viz.*, germination (92.50%), root shoot length (11.08 cm), vigour index I (986.27) were significantly superior in KNO_3 @ 2% and Borax @ 100 ppm (Separate spray) at the reproductive stage irrespective of sowing dates and cutting regimes than without nutritional spray treatment. It

might be the role of potash which may improves grain filling and phytomass production due to photosynthetic activity and effective translocation of assimilates to reproductive parts resulting in higher grain yield (Nigam *et al.,* 2010). The significant response of the potassium to seed yield in berseem (*Trifolium alexandrinum* L.) was observed by Attia (1996) and moreover, it is pronounced that the higher N rates because of a significant N × K interaction. In terms of nutrient absorption, foliar fertilization can be from 8 to 20 times as efficient as ground application (Kuepper, 2003). Kumar *et al.* (2013) also reported that foliar application of salicylic acid at 50 mg-l^{-1} and KNO_3 (2%) produced the maximum heads m^{-2}, seeds $head^{-1}$, 1000 seed weight, seed yield and seed quality (germination percentage and seedling vigor index) in Egyptian clover. Similar results were reported by Farooq *et al*. (2017) observed seed yield improvement due to foliar spray of potash in Berseem.

Boron is an essential micronutrient for the normal growth and development of plants. It plays an important role in flowering and fertilization process as well as higher yield and quality of crop produce. Khurana *et al.* (2012) in a field study reported higher berseem fodder yield increased significantly in the first and second cuttings by boron application. The increase in seed yield with foliar application of boron was due to more absorption of boron which resulted in increases stalk length, helps in pollination, increases seed production, moves sugar and starch, makes proteins and helps in nodule formation. These results are in accordance with the findings of Ratanart *et al*. (1989) who reported similar results for peanut in black calcareous soils.

3.4 Interaction Effect of Sowing Dates, Cutting Regimes and Nutritional Spray on Berseem Seed Yield and Quality

The data on interaction effect of sowing dates, cutting regimes and nutritional spray at the time of reproductive stage on seed yield and quality of berseem are presented in Table 3 and 4. The seed yield and quality parameters of berseem were significantly influenced due to different treatment combinations of sowing dates, cutting regimes and nutritional

Table 3: Interaction effect of sowing date, cutting regimes and nutritional spray on plant growth and seed yield parameters in berseem

Treatments	Days to 50% flowering*	No. of flowers/ plant	No. of florets per flower	No. of seeds/ flower	Length of inflorescence (cm)	Plant height (cm)	Ovule to seed ratio	Days to maturity*	Seed yield/ plot (g)	Seed yield (q/ha)
$S_1C_1N_1$	33.75	28.95	55.55	36.45	1.98	49.20	1.49	165.75	154.25	1.313
$S_1C_1N_2$	28.50	41.85	73.65	52.35	2.45	64.35	1.52	162.25	236.50	1.335
S_1C2N_1	35.25	18.75	49.10	27.90	1.75	35.92	1.25	166.50	113.00	0.925
S_1C2N_2	30.75	29.60	59.10	43.60	2.08	56.10	1.26	164.50	223.75	0.965
$S2C_1N_1$	28.50	24.80	54.35	35.40	1.85	42.00	1.34	166.25	148.00	0.691
$S2C_1N_2$	27.00	36.65	69.00	49.05	2.33	60.73	1.43	163.50	195.50	0.738
$S_2C_2N_1$	27.75	12.70	41.80	20.75	1.68	29.3	1.49	167.75	115.00	1.010
$S_2C_2N_2$	26.00	29.60	59.10	43.60	2.08	56.10	1.66	164.50	161.50	1.254
SE ±	0.667	1.155	1.911	1.572	0.114	2.309	0.051	1.625	4.963	0.037
CD at 5%	NS	3.399	NS	4.591	NS	NS	NS	NS	14.490	0.108

*From last cut date, S_1 = Normal (15th Oct.), S_2 = Late (15th Jan.), C_1 = 10 days before normal last cut, C_2 = 10 days after normal last cut, N_1 = No spray (Control), N_2 = KNO_3 @ 2% and Borax @ 100 ppm

spray at the time of reproductive stage. Number of flowers $plant^{-1}$ (41), Number of seeds $flower^{-1}$ (52), seed $yield^{-1}$ (226 g), seed yield ha^{-1} (1.34 q) and days to 50% flowering (116) were significantly superior in the sowing at normal sowing time *i.e.* 15th October, last cut 10 days before normal last cut *i.e.* 18th Feb. and nutritional spray of KNO_3 @ 2% and Borax @ 100 ppm (Separate spray) at the reproductive stage ($S_1C_1N_2$) over the other treatment combinations. Similarly, seed quality parameters *viz.*, germination (94.00%) was significantly superior in the same treatment combination. However, Number of florets per flower, length of flower, ovule to seed ratio, 1000 seed weight , Plant height, days to 50% flowering and maturity, root shoot length and vigour index I were not influenced significantly. Further, the availability of pollinators and congenial climatic conditions for the early cut material has helped in attaining maximum seed yield. Iannucci (2001), Usmani *et al*. (2001) and Bakheit *et al*. (2012) found that high temperature during the growing season of berseem clover may affect the seasonal distribution of both forage and seed yields. Further, the availability of pollinators and congenial climatic conditions for the early cut material has helped in attaining maximum seed yield. Misra *et al.* (2012) also found the seed yield and the test weight of the seeds increased with each successive increase in the K level in berseem. Dhaliwal

Table 4: Interaction effect of sowing date, cutting regimes and nutritional spray on seed quality attributes in berseem

Treatments	Days to 50% flowering*	No. of flowers/ plant	No. of florets per flower	No. of seeds/ flower
$S_1C_1N_1$	2.10	88.50	9.97	868.10
$S_1C_1N_2$	2.27	94.00	12.37	1132.50
S_1C2N_1	2.00	85.50	9.45	788.90
S_1C2N_2	2.15	93.00	10.20	890.60
$S2C_1N_1$	2.10	88.00	9.62	819.45
$S2C_1N_2$	2.22	92.00	11.57	1031.40
$S_2C_2N_1$	1.92	79.00	9.30	767.85
$S_2C_2N_2$	2.15	91.00	10.20	890.60
SE ±	0.050	0.878	0.411	37.153
CD at 5%	NS	2.563	NS	NS

*From last cut date, S_1 = Normal (15th Oct.), S_2= Late (15th Jan.), C_1=10 days before normal last cut, C_2=10 days after normal last cut, N_1=No spray (Control), N_2=KNO_3 @ 2% and Borax @ 100 ppm

et al. (2008) reported higher yields with micronutrient sprays of Zn, Mn, Mo and B on loamy sand soil.

4. Conclusion

The berseem seed yield and seed quality attributing parameters were significantly superior in the at normal sowing time *i.e.* 15th October with the nutritional spray of KNO_3 @ 2% and Borax @ 100 ppm (Separate spray) at the reproductive stage and last cut prior to 10 days before normal last cut under agro ecological conditions of western Maharashtra.

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