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Effect of cutting management on seed yield and quality attributes of tetraploid berseem

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Abstract
Berseem is an important *rabi* fodder crop in India but its seed productivity is quite low compared to other countries. Tetraploid varieties have a margin in seed size and fodder quantity than diploid varieties however, their yield potential is low. The present study was conducted in the newly developed bold seeded tetraploid berseem variety, Bundel Berseem-3 (BB-3), to improve the seed yield through cutting management by taking differential date of last cut. Influence of last cut on various phenophases, yield parameters, seed yield and quality was studied. Significant differences were noted in the flowering period as well as yield attributes under various cutting regimes. Seed yield decreased with increased date of last cut. Seed quality measured in terms of germination and vigour also decreased with delay in date of last cut. February ending to March I week was found to be the more suitable period for last cut in Bundel Berseem-3 variety in areas where the temperature range is between 5-27°C (Min.) and 22-41°C (Max.) during February to May.

Keywords: Cutting management, Date of last cut, Phenology, Seed yield, Tetraploid berseem

Introduction

Berseem (*Trifolium alexandrinum* L.) commonly known as Egyptian clover, is one of the major *rabi* forage crops occupying maximum area during winter season in India (Hazra, 1995). It is an annual leguminous crop, well adapted to the semi-arid conditions of the Northern India with good nitrogen fixing ability. Berseem fodder is highly palatable due to its succulence and nutritious with 20% crude protein and 62% total digestible nutrients. This crop provides fodder for a long season *i.e*., from November to May with as much as 80-90 t green fodder per hectare through multiple cuttings. Additionally being a legume crop, berseem cultivation aids in substantial improvement in soil fertility. The success of any crop production depends mainly on the availability of the seed, which is one of the critical input for the agriculture. Quality seeds will enhance the yield and biomass. In general, the seed yield in forages is comparatively low due to their excessive vegetative growth as well as reduced seed set. There is an increasing demand for berseem seed in India with lot of seed being imported every year from Egypt. This shows the existing potential for increase in berseem seed production and marketing in India.

Berseem is generally sown during October/ November and after taking 3-4 cuttings up to the month of March, the crop is left for seed production in central India. Seed production depends on many factors and time of harvest is one among them. The suitable period of last cut for quality seed yield is not studied in Bundel Berseem-3 (BB-3), a newly developed tetraploid variety with bold seeded nature. The seed yield of BB-3 variety is comparatively low due to its tetraploid nature. The fertility level of tetraploid varieties is comparatively less than diploid varieties (Dixit *et al.*, 1989). Due to its bold seededness and higher fodder yield this variety is rapidly gaining popularity in the national seed chain. Till date there is no study on the effect of date of last cut on seed quality of a tetraploid variety. Hence, the present study was taken up to find out the effect of date of last cut on seed yield as well as quality in tetraploid berseem.

Materials and Methods

Site and sowing information: Field experiment was carried out during winter season from November to March of 2012 and 2013 at the Central Research Farm of Indian Grassland and Fodder Research Institute, Jhansi, India. Seeds of BB-3 variety, harvested during previous *rabi* were used for sowing. At appropriate soil moisture, field was ploughed twice followed by harrowing and planking. Seed was sown at the rate of 25 kg/ha in twelve rows at 50 cm distance in 3 × 6 m plots in four replications. Weeding was done twice manually along with recommended dose of fertilizers and scheduled irrigation.

Cutting treatments: Six cutting treatments spread over January to March were imposed before leaving the crop for seed production. The last cut was taken on January 23rd (T_1), February 17th (T_2), 25th (T_3), March 7th (T_4), 9th (T_5) and 31st (T_6) in four replications.

Pre and post-harvest observations: The pre-harvest observations include days to 50 per cent flowering, days to 100 per cent flowering and days to maturity from date of sowing as well as date of last cut. The post-harvest observations consist of head length, number of flowers per head, number of seeds per head, seed to ovule ratio and 100 seed weight were recorded from ten heads each at two blooms along with seed yield after harvesting.

Seed Germination: Germination was tested in 4 replications with 100 seed each using top of the paper method at 20°C and 85% RH for 7 days ISTA (2011). The seedlings were evaluated and grouped into normal and abnormal seedlings. Germination percentage was calculated as number of normal seedlings obtained out of total seeds kept for germination.

Seedling dry weight: It was estimated in four replications by following standard method (Gupta, 1993). Ten normal seedlings from germination test were weighed after drying at 100°C for 24 h. The seedlings were cooled to room temperature in a desiccator with silica gel before taking weight.

Seed vigour index: Seed vigour was quantified in terms of vigour index as per Perry (1978). Seed vigour index was measured as a product of germination percentage and seedling dry weight in grams.

Data analysis: The pooled data were analysed using standard method of Analysis for Variance (ANOVA) for single factor Randomized Block Design for field experiment as per Snedecor and Cochran (1994). The Least significant difference was noted at probability of less than 0.05.

Results and Discussion

Phenological studies: Flowering phenology was observed from sowing as well as date of last cut. Consistent increase in number of days from sowing to attain various flowering stages was observed with delay in date of last cut. Last cut on 31st March recorded highest number of days from sowing to 50 per cent flowering (153 days), complete flowering (161 days) and days to maturity (179 days). Even though phenology is one of the genetically controlled character specific to the cultivar, it is highly influenced by the management practices as well as climatic conditions. Since plant requires certain vegetative growth before initiation of reproductive phase, delay in last cut has resulted in increase in number of days to flower from sowing. Similar results were found by other workers in diploid berseem, where the total time for reproductive phase (period from flower initiation to seed maturity) was substantially increased with delay in last cut (Sardana and Narwal, 2000).

The time period from sowing to flowering initiation and seed maturity is inversely related to the time period taken for the same from last cut. The days to 50 per cent flowering were reduced from 54 days in January 23rd cut to mere 13 days in March 31st cut and significant difference was observed even among other cutting dates (Table 1). Similar results were obtained for days to 100 per cent flowering and days to maturity where the span of reproductive phase was decreased. Berseem being an annual winter legume crop, its transition from vegetative to reproductive phase is influenced by photo and thermo periods. Interestingly the gap between flowering and maturity was decreased up to 25th February cutting and later increased in March last cuts. Partitioning of flowering to maturity duration indicated that time period between 50 per cent to complete flowering is not significantly changed with the date of last cut. However, the duration from 100 per cent flowering to maturity was decreased up to Feb III week and later increased resulting in increase in flowering to maturity duration (Fig. 1).These changes may be due to the interaction of various weather parameters on flowering and seed maturity particularly the increase in sunshine hours during Feb III week (Table 4) might have reduced the flowering to maturity duration and *vice versa*.

Table 1. Effect of date of last cut on flowering and maturity in berseem variety BB-3

Date of last cut	Days to 50% flowering		Days to 100% flowering		Days to maturity	
	From sowing	From last cut	From sowing	From last cut	From sowing	From last cut
23rd Jan	126.25	54.25	135.20	63.20	146.25	74.25
17th Feb	144.25	47.25	152.32	55.32	160.25	63.25
25th Feb	146.25	41.25	154.20	49.20	161.25	56.25
7th Mar	150.50	34.50	159.02	43.03	169.50	53.50
19th Mar	152.25	24.25	160.55	32.55	177.00	49.00
31st Mar	153.75	13.75	161.42	21.43	179.75	39.75
SEM	0.63		0.61		0.60	
$LSD_{0.05}$	1.89		1.82		1.81	

Table 2. Influence of date of last cut on flower and seed setting

Date of last cut	Head length (cm)		No. of flowers per head		No. of seeds per head		Seed to ovule ratio	
	I Flush	II Flush	I Flush	II Flush	I Flush	II Flush	I Flush	II Flush
23rd Jan	2.41	2.88	99.10	112.45	30.70	34.85	0.31	0.31
17th Feb	2.51	2.76	102.60	121.10	25.60	31.45	0.25	0.26
25th Feb	2.63	2.62	109.55	109.20	33.05	30.15	0.30	0.28
07th Mar	2.49	2.44	102.05	93.50	32.90	30.30	0.32	0.33
19th Mar	2.33	2.09	92.50	91.10	27.90	26.70	0.30	0.29
31st Mar	1.71	1.99	81.50	73.45	12.45	8.60	0.15	0.11
SEM	0.12	0.08	4.07	4.88	1.91	3.13	0.02	0.03
$LSD_{0.05}$	0.37	0.23	12.26	14.72	5.76	9.98	0.06	0.09

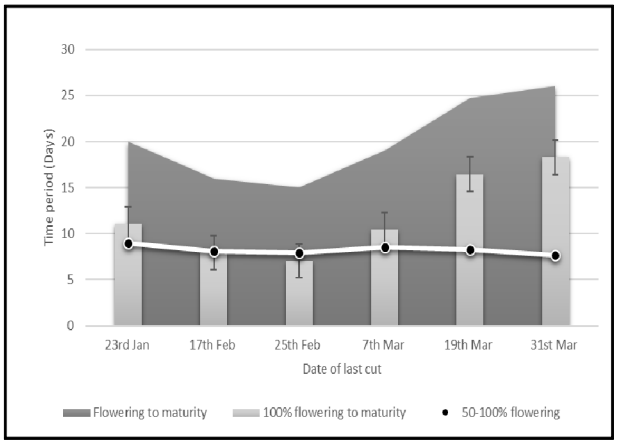

Fig 1. Partitioning of duration of flowering to maturity as influenced by date of last cut

Head characters under different blooms: In berseem, flowering occurs in flushes and early flushes contains maximum number flower heads with big size. While the later flushes have decreased size and number of flower heads. In the present study head characters from first two flushes were recorded. No significant difference was observed in the head length and number of flowers per head during first flush of flowering under different cuttings except for the March 31st cut which was significantly lower (1.71 cm & 81). However, during second flush differences were noticed with significant reduction in head length as well as number of flowers per head in March month cuttings (Table 2).This indicates that head characters (length and number of flowers) during first flush of flowering are not much influenced with date of last cut. Similar results were observed by Kumar and Verma (2003). The decrease in head length and number of flowers per head during II flush in March month cuts can be attributed to increase in temperature (Table 4), decreased nutrient availability and increased ageing on head characters. Under very late cutting even the seed to ovule ratio was drastically reduced (0.1) as observed in the March 31st cutting treatment. The increased temperature not only affect the bee (main pollinator) activity but also reduces pollen fertility resulting in reduced seed set in crops like berseem where tripping mechanism is needed for seed setting (Dixit *et al*., 1989).The decrease in number of seeds per head with delayed sowing due to reduced growth period was observed by Din *et al*. (2014). In the present study also reduction in days to maturity from date of last cut (Table 1) resulted in decline of number of seeds per head during March month (Table 3).

Table 3. Seed yield and its attributing characters as influenced by date of last cut

Date of last cut	No. of seeds per head	Seed to ovule ratio	100 seed weight (g)	Seed yield (q/ha)
23rd Jan	32.78	0.31	0.343	2.83
17th Feb	28.53	0.25	0.318	1.72
25th Feb	31.60	0.29	0.314	1.73
07th Mar	31.60	0.32	0.301	1.66
19th Mar	27.30	0.30	0.312	1.27
31st Mar	10.53	0.13	0.290	0.43
SEM	2.16	0.02	0.012	0.21
$LSD_{0.05}$	6.51	0.06	0.038	0.40

Seed yield: Seed yield got reduced with delay in date of last cut. Maximum yield (2.83 q/ha) was obtained during January last week cutting indicating that by leaving the crop for sufficient vegetative growth will result in higher seed production. Further, the availability of pollinators and congenial climatic conditions for the early cut material has helped in attaining maximum seed yield. The last cut in February moth resulted in 1.7 q/ha and March I week 1.6 q/ ha which are statistically on par (Table 3). Since fodder is also an economic product in berseem crop, the last cut up to March I week provides ample time to have three cuts for fodder even in October ending / November I week sowing. This implies that the last cut up to March I week can strike a balance between fodder yield and seed yield. The seed yield reduction with delay in last cut can be attributed to several factors *viz*., decrease in head length, number of flowers per head, seed set per cent and seed test weight (Table 3). These declines are influenced by weather parameters like temperature and photoperiod. The increase in maximum and

minimum temperature with the delay in last cut (Table 4) might be the reason for 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).

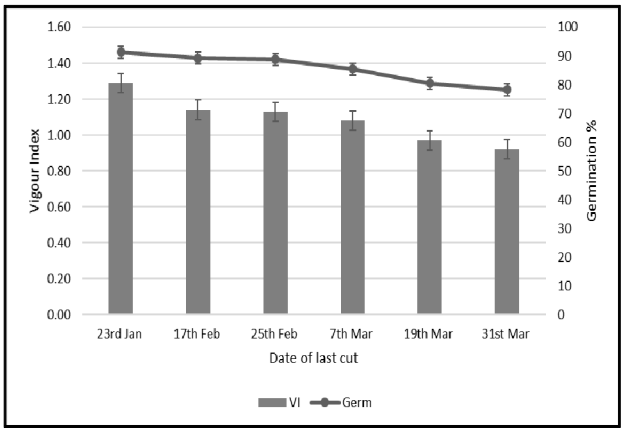

Fig 2. Germination and vigour index (VI) of berseem seeds from different last cuts

though germination was reduced, the seedling dry weight was not affected due to delay in date of last cut resulting in lack of significant difference in vigour index.

Thus, the present study on cutting management revealed that, February last week to March I week can be recommended for taking last cut of fodder and then leaving the crop for seed production in tetraploid berseem (BB-3). This helps in striking a balance between both economic commodities, fodder and seed, as well as to maintain seed quality in regions where the temperature range is 5-27°C (Minimum temperature) and 22-41°C (Maximum temperature) during February to May. This study also provides a cue for further study on the relationship between accumulation of photoperiod and suitable temperatures *vis-à-vis* flowering, thereby identifying the precise time for flowering and hence alter the sowing durations with respect to seed production purpose without increasing large biomass leading to lodging and unnecessary vegetative matter in commercial seed production plots.

Table 4. Weather parameters during last cut dates for the two growing seasons

Season	Weather parameter	Standard meteorological week coinciding with last cuts					
		Jan IV week	Feb II week	Feb III week	Mar I week	Mar III week	Mar IV week
2012	Maximum temperature (°C)	20.1	23.9	29.2	29.9	34.2	36.9
	Minimum temperature (°C)	5.4	8.2	10.4	10.8	13.3	15.1
	Relative humidity (%)	91	89	87	73	76	74
	Sunshine duration (h)	8.4	8	9.8	9.6	9.2	9.1
2013	Maximum temperature (°C)	21.9	23.7	25.6	32.3	33.7	32.3
	Minimum temperature (°C)	3.1	11.1	10	12.4	15.6	15.4
	Relative humidity (%)	87	91	88	84	78	82
	Sunshine duration (h)	9.2	5.9	9	10.3	9.6	8.2
Average	Maximum temperature (°C)	21.0	23.8	27.4	31.1	33.9	34.6
	Minimum temperature (°C)	4.25	9.65	10.2	11.6	14.45	15.25
	Relative humidity (%)	89	90	87.5	78.5	77	78
	Sunshine duration (h)	8.8	6.95	9.4	9.95	9.4	8.65

Seed germination and vigour: There was a gradual decline in germination from 89 to 78 per cent in the seed collected from different dates of last cut i.e. from January 23rd to March 31st. No significant difference in the germination percentage was observed between January and February cutting treatments. However, significant reduction was noticed in the seeds harvested from March month cuttings (Fig. 2). This can be ascribed to the shorter period of vegetative and reproductive phases along with the increase in temperature during March month. The seedling vigour quantified as vigour index based on seedling dry weight showed no significant difference with the delay in last cut except the January last week cutting which showed highest vigour index (1.25). Even

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