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EFFECTS OF SEED PRIMING AND NUMBER OF CUTTINGS ON GROWTH, YIELD COMPONENTS, AND SEED PRODUCTION OF LATE SOWN BERSEEM

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Article Info

Abstract

A research experiment was conducted at Agronomy Research Farm, The University of Agriculture Peshawar during season 2017-2018. The research was carried out in randomized complete block design with three replications having two factors. Factor A was seed priming with different agents (non-primed seeds, 1% NaCl, 2% KNO_3, PEG-6000, 1:30 MLE and 50ppm GA_3) while factor B was stop cutting at different intervals (no cut, 10th April, 20th April, 30th April and 10th May). Seed priming had significant effect on all parameters except harvest index. Highest emergence m^{-2} (214), less weeds m^{-2} (63), a greater number of branches $plant^{-1}$ (5.7), fresh forage yield (42750 kg ha^{-1}), dry fodder yield (4808kg ha^{-1}), plant height (44.26 cm), biological yield (4991 kg ha^{-1}), seed yield (556 kg ha^{-1}) and 1000 seed weight (3.10 g) were recorded at seed priming with moringa leaves extract. Less number of days (144) to flowering was recorded with KNO_3 seed priming. Similarly, a greater number of heads m^{-2} (2205), seeds $head^{-1}$ (49) were noticed with gibberellic acid priming. Stop cutting time also showed significant effect on most of parameters. Highest fresh forage yield (41043 kg ha^{-1}), dry fodder yield (4348 kg ha^{-1}) and Heads m^{-2} (2193) were recorded with stop cuttings at 20th April. Number of seeds $head^{-1}$(54), 1000 seed weight (3.06 g) and seed yield (607kg ha^{-1}) were highest in plots where cutting was stopped at 30th April. Highest data were recorded on plant height (51.55 cm), number of branches $plant^{-1}$ (6.3) and biological yield (4784 kg ha^{-1}) in plots where no cut was given to crop. Less number of days (139) to flowering was recorded in control plots with no cutting. Highest harvest index (22.74 %) data were noted in plots where cutting was stopped at 10th May. It was concluded that priming berseem seeds with moringa leaves extracts and stop cutting at 20th and 30th April increased the yield components and seed yield of berseem and is therefore, recommended for obtaining better seed yield of berseem under the environmental conditions of Peshawar.

Keywords: *Seed Priming, Number of Cuttings, Yield Components, Seed Production, Late Sown, Berseem.*

INTRODUCTION

Berseem clover (*Trifolium alexandrinum* L.) belongs to the family Fabaceae and is the most important winter forage legume across Pakistan, contributing more than fifty% of the country's annual green forage. Agriculture sector contributes 19.83% in country GDP and 42.34% of the country's total labour force (ESP, 2016). Berseem is cultivated in all irrigated areas of Pakistan. Berseem was cultivated in Pakistan on an area of 0.7 million hectares with a production of 22.61 million tons of green forage and average yield of 22857 kg ha^{-1} (PARC, 2017). The demand for berseem forage had increased in recent years but its production is low. The main reasons for the low berseem clover forage production are dependence on native varieties, non-adoption off improved technologies such as seed treatment and imbalance amount of nutrients supplied to the crop.

Berseem grows best on fertile soil with moderate tolerance to salinity (Adnan et al., 2025). It has a strong tap root system, hallow stem, leaves are juicy and trifoliate with white and tiny flowers. It has 2.95% phosphorous, 18.31% protein, 2.62% calcium, 20 ppm carotenes and is also a rich source of vitamin-A (Akram et al., 2022). It improves soil fertility and soil physical properties. Berseem crop is also called trap crop and is grown on sides of main crop to attract natural predators of pests. Many fodder crops are grown in Pakistan but berseem is known as king of fodders due to its growth characters and quick regeneration power. (Abir et al., 2022). Due to its nutritious value and high palatability berseem is highly liked by animals and is known as milk multiplier. It helps to improve soil fertility through biological nitrogen fixation and therefore, helps to lower the quantity of nitrogenous fertilizer required by berseem crop (Abbas et al., 2024). The yield and quality of berseem is less in our country due to many environmental factors and different management limitations (Arshad et al; 2018). This crop usually fits with the local crop rotation systems (Arshad et al., 2022) and therefore, it is commonly grown as a dual-purpose crop i.e. for both forage and seed (Chattha, et al., 2018). Cutting is an important practice for increasing the forage yield. (Din et al., 2014) and it is the most crucial agronomic factor which directly affects plants morphology and expression of yield potential, and indirectly influences forage nutrition (Faridi et al., 2014). Reducing the cutting interval results in increase in crude protein. (Gondal et al., 2022). Proper stand establishment is very important for enhancing field production of any crop. At suboptimal environmental conditions, poor germination and subsequently poor crop establishment is a common phenomenon. Seed priming might play a crucial role in faster seed germination and emergence, and is therefore necessary for successful stand establishment of crops (Iqbal et al., 2026). Seed germination of crops at low temperatures can be enhanced by certain seed treatments such as priming. Priming is a pre-sowing treatment of seeds with osmotic solution allowing seeds to imbibe water to ensure the first stage off germination, but prevents radicle protrusion from seed coat (Jabbar et al., (a) 2022). Seed priming theory was first proposed by Heydecker in 1973. Seed priming generally reduces germination time, improve seedling vigour and results in earlier crop maturity, avoiding temperature and other environmental stresses (Jabbar et al., (b) 2022). Beneficial effects of priming on forage seeds have been reported however there is lack of information related to seed priming on seeds of berseem in literature. Therefore, the present study was conducted to determine the effect of seed priming and cutting management for higher berseem seed yield kg ha^{-1} under the climatic conditions of Peshawar valley.

MATERIALS AND METHODS

To investigate the effects of seed priming and the number of cuttings on berseem growth, a field experiment was conducted at the Agronomy Research Farm, The University of Agriculture, Peshawar, during the winter seasons of 2017 and 2018. The experiment was laid out in a randomized complete block design (RCBD) with three replications, using a plot size of 3 m × 2.2 m. The experiment consists of two factors; Factor A was seed priming while Factor B was number of cuttings. Priming was done by pre-soaking the seeds in different priming solutions for 18 hours at 20˚C in darkness. The seeds of local variety was sown in standing water @ of 30 kg ha^{-I} on 29 December, 2017. A basic fertilizer dose of 30:60 kg NP ha^{-I} was applied before sowing. Weeding was done for weeds observed in field such as *Convolvulus arvensis*, *Euphorbia helioscopia*, *Avena fatua*, *Cichorium intybus*, *Melilotus officinalis, Rumex crispus* and *Fumaria officinalis.* Similarly, irrigation was done according to the requirements of field and crop throughout the growing season.

FACTOR A (Seed priming)

P_0 = Non primed
P_1= 1% NaCl
P_2 = 30% PEG-6000
P_3 = 2% KNO_3
P_4 = 1: 30 MLE (Moringa leaves extracts)
P_5 = 50 ppm GA_3

FACTOR B (Stop Cutting)

SC_0 = Check
SC_1 =10^{th} April
SC_2 = 20^{th} April
SC_3 = 30^{th} April
SC_4 = 10^{th} May

Procedure for seed priming

For preparation of MLE, leaf extraction was performed by grinding young shoots (leaves and tender branches) with a pinch of water in a locally fabricated extraction machine. After sieving through cheese cloth MLE 1: 30 dilution of the extract were prepared with distilled water and was then used in experiments for priming. For 1% NaCl solution 10 gram of NaCl was mixed in one liter of water. For 2% KNO_3 solution 20 gram KNO_3 was dissolved in one liter of water. 50ppm GA_3 solution was prepared by adding 50 mg of gibberellic acid in one liter water. 30% PEG solution was prepared by adding 300 g of PEG-6000 in one liter water. The ratio of seed weight to solution volume was kept at 1:5. After priming, seeds were given 3 washes with distilled water and redried to near their original weight under shade at23 ± 3 °C. The seeds were used immediately after redrying (Nauman et al., 2012).

The following parameters were recorded during field experiment.

1. Emergence m^{-2}

2. Weeds m^{-2}
3. Days to flowering
4. Plant height (cm)
5. Fresh forage yield (kg ha^{-1})
6. Dry fodder yield (kg ha^{-1})
7. No of branches $plant^{-1}$ at the time of each cut
8. No of heads m^{-2}
9. No of seeds $head^{-1}$
10. 1000 seeds weight (g)
11. Biological yield (kg ha^{-1})
12. Seed yield (kg ha^{-1})
13. Harvest index (%)

Statistical analysis

The data recorded was analysed statistically by using analysis of variance techniques appropriate for randomized complete block design. Means were compared using LSD test having level of probability of 0.05, when the F-values is significant (Jan et al., 2009).

RESULTS

Emergence m^{-2}

Data regarding emergence m^{-2} of berseem as effected by seed priming and number of cuttings is shown in table 1. Statistical analysis of data showed that emergence m^{-2} of berseem was significantly affected by seed priming while cutting had non-significant effect on it. The interaction between seed priming and cutting remains non-significant. Highest (214) emergence m^{-2} was recorded by priming berseem seeds with moringa leaves extract while lowest (155) was recorded with non-primed seeds.

Table 1. Emergence m^{-2} of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	153	162	173	183	213	194	180
10th April	154	162	174	184	213	195	181
20th April	155	162	173	184	216	194	181
30th April	156	162	172	184	214	194	180
10th May	155	162	173	185	215	193	181
Mean	155 f	162 e	173 d	184 c	214 a	194 b	

LSD (0.05) for Priming = 1
LSD (0.05) for Stop cuts = ns
LSD (0.05) for Priming × stop cut = ns

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Weeds m^{-2}

Weeds m^{-2} data are shown in table 2. Analysis of variance of data indicates that seed priming had significant effect on number of weeds m^{-2} in berseem crop. Similarly, cutting berseem at different timings showed non-significant effect on weeds. The interaction is also found non-significant. Less (63) weeds were found in plots treated with moringa leaves extract while higher number of weeds (114) were found in non-primed seeds.

Table 2. Weeds m^{-2} of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	114	104	96	85	62	72	89
10th April	112	104	96	82	63	74	89
20th April	116	105	91	84	64	76	89
30th April	114	104	92	83	64	74	89
10th May	111	103	92	85	64	73	88
Mean	114 a	104 b	93 c	84 d	63 f	74 e	

LSD (0.05) for Priming = 2
LSD (0.05) for Stop cuts = ns
LSD (0.05) for Priming × stop cut = ns

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Days to flowering

Days to flowering data are showed in table 3. Statistical analysis of data revealed that days to flowering data were significantly affected by seed priming and stop cuttings. However, their interaction was found non-significant. Plots treated with moringa leaves extract priming took more (152) days to flowering while KNO3 primed seeds plots took less (144) days to reach to flowering stage. However, in plots where cutting was stop at 10th May took more (153) days to reach to flowering and less days to flowering (139) were recorded in control plots.

Table 3. Days to flowering of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	136	138	136	139	145	141	139 e

10th April	140	142	141	141	150	144	143 d
20th April	146	146	143	146	154	146	147 c
30th April	148	149	148	148	156	150	150 b
10th May	151	153	151	151	158	156	153 a
Mean	144 e	146 d	144 e	145 d	153 a	148 b	

LSD (0.05) for Priming = 1
LSD (0.05) for Stop cuts = 1
LSD (0.05) for Priming × stop cut = *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Plant height (cm)

Plant height data are presented in table 4. Statistical analysis of variance of data showed that plant height of berseem is significantly influenced with both seed priming and stop cutting. Similarly, their interaction was also found significant. Data analysis indicates that highest plant height was recorded with moringa leaves extract seed priming (44.26) followed by (43.50) seeds primed with gibberellic acid while lower plant height (31.24) was recorded in plots treated with non-primed seeds. Similarly, control plots gives highest plant height (51.55) while lowest plant height (31.09) was observed in plots where cutting was stop at 30th April.

Table 4. Plant height (cm) of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	44.02	48.64	47.21	53.42	59.21	56.79	51.55 a
10th April	36.62	40.11	38.98	43.98	48.94	47.67	42.72 b
20th April	27.71	32.53	30.82	36.70	40.27	40.05	34.68 c
30th April	24.07	29.01	27.08	33.65	36.43	36.27	31.09 d
10th May	23.78	29.25	27.43	33.23	36.45	36.74	31.14 d
Mean	31.24 f	35.91 d	34.30 e	40.19 c	44.26 a	43.50 b	

LSD (0.05) for Priming = 0.33
LSD (0.05) for Stop cuts = 0.30
LSD (0.05) for Priming × stop cut = *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

No of branches plant^{-1} at the time of each cut

Data regarding number of branches plant^{-1} are given in table 5. Analysis of variance of data revealed that number of branches are significantly affected by both seed priming and stop cuts. The interaction between both factors were found non-significant. Highest number of branches (5.7) were recorded in plots treated with MLE seed priming while lowest number of branches (4.4) were observed in non-primed seeds plots. Similarly, highest number of branches (6.3) were observed in plots with no cutting while lowest number of branches (3.8) were produced in plots where cutting was stop at 10th May.

Table 5. Number of branches plant^{-1} of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	5.6	5.8	6.2	6.6	7.8	5.9	6.3 a
10th April	4.3	4.9	4.0	5.3	5.0	4.9	4.7 c
20th April	4.8	4.8	5.0	6.2	5.7	5.8	5.3 b
30th April	4.3	5.2	4.2	5.1	5.4	5.2	4.9 c
10th May	3.0	3.6	3.7	4.1	4.6	4.1	3.8 d
Mean	4.4 e	4.8 cd	4.6 de	5.5 ab	5.7 a	5.2 bc	

LSD (0.05) for Priming = 0.4
LSD (0.05) for Stop cuts = 0.4
LSD (0.05) for Priming × stop cut = ns

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Number of heads m^{-2}

Data regarding number of heads m^{-2} are given in table 6. Analysis of variance of data revealed that number of heads are significantly affected by both seed priming and stop cuts. The interaction between both factors was also found significant. Highest number of heads (2205) were recorded in plots treated with gibberellic acid seed priming followed by (1989) in plots treated with moringa leaves extract seed priming while lowest number of heads (1912) were observed in non-primed seeds plots. Similarly, highest number of heads (2193) were observed in plots where cutting was stop at 20th April while lowest number of heads (1893) were produced in plots where cutting was stop at 10th May.

Table 6. Number of heads m^{-2} of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	1867	1896	1876	1915	1923	1966	1907 d
10th April	1917	1936	1939	1959	1981	2021	1959 c
20th April	1984	2018	2001	2069	2079	3009	2193 a
30th April	1940	1954	1946	2016	2052	2085	1999 b
10th May	1852	1891	1858	1900	1910	1944	1893 e
Mean	1912 f	1939 d	1924 e	1972 c	1989 b	2205 a	

LSD (0.05) for Priming = 1
LSD (0.05) for Stop cuts = 1
LSD (0.05) for Priming × stop cut= *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Number of seeds head^{-1}

Number of seeds head^{-1} data are showed in table 7. Statistical analysis of data showed that seed priming and cutting significantly affect number of seeds per head. The interaction was also found significant. Highest number of seeds (48, 49) were recorded in plots treated with moringa leaves extract priming and gibberellic acid while lowest number of seeds (41) were observed in plots treated with KNO_3 seed priming. However, higher number of seeds(54) were recorded in plots where cutting was stop at 30th April while lower number of seeds (38) were recorded in control plots.

Table 7. Number of seeds head^{-1} of berseem as affected by seed priming and number *of cuttings*.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	35	41	33	37	41	41	38 e
10th April	43	45	38	42	49	47	44 c
20th April	47	51	46	46	54	53	49 b
30th April	52	54	51	51	56	58	54 a
10th May	39	42	35	40	43	45	41 d

Mean	43 c	46 b	41 d	43 c	48 a	49 a	

LSD (0.05) for Priming = 1
LSD (0.05) for Stop cuts = 1
LSD (0.05) for Priming × stop cut= *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Fresh forage yield (kg ha^{-1})

Fresh forage data are presented in table 8. Data analysis of fresh forage yield was influenced by seed priming and stop cuttings. Similarly, their interaction is also found significant. Data analysis indicates that highest fresh forage yield was recorded with moringa leaves extract priming (42750) followed by (37806) seeds primed with gibberellic acid while lowest yield (29421) was recorded with non-primed seeds. Similarly, stop cutting at 20th April gives maximum yield (41043) while stop cutting at 10th April gives lowest yield (27722).

Table 8. Fresh forage yield (kg ha^{-1}) of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
10th April	22320	24610	27147	27520	34587	30147	27722 d
20th April	34578	36550	39928	41022	49957	44223	41043 a
30th April	33622	35616	36074	38963	47328	41746	38891 b
10th May	27164	28955	29695	32246	39131	35109	32050 c
Mean	29421 f	31433 e	33211 d	34938 c	42750 a	37806 b	

LSD (0.05) for Priming = 573
LSD (0.05) for Stop cuts = 468
LSD (0.05) for Priming × stop cut = *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Dry fodder yield (kg ha^{-1})

Data regarding dry fodder yield are presented in table 9. Statistical analysis of variance of data showed that dry fodder yield is significantly influenced with both seed priming and stop cutting. Similarly their interaction is also found significant. Data analysis indicates that highest dry fodder yield was recorded with moringa leaves extract seed priming (4808) followed by (4477) seeds primed with gibberellic acid while lowest yield (3253) was recorded with non-primed seeds. Similarly, stop cutting at 20th April gives maximum yield (4348) while stop cutting at 10th May gives lowest yield (3613).

Table 9. Dry fodder yield (kg ha^{-1}) of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
10th April	2813	3347	3057	3817	4583	4187	3634 c
20th April	3647	4067	3877	4375	5185	4935	4348 a
30th April	3581	4003	3784	4301	5030	4709	4235 b
10th May	2972	3361	3136	3700	4432	4077	3613 d
Mean	3253 f	3694 d	3463 e	4048 c	4808 a	4477 b	

LSD (0.05) for Priming = 36
LSD (0.05) for Stop cuts = 29
LSD (0.05) for Priming × stop cut= *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

1000 seed weight (g)

Data relating to 1000 seed weight is presented in table 10. Statistical analysis of data indicates that seed priming and stop cutting gives significant effect on 1000 seed weight. However, the interaction between cutting and priming is found to be non-significant. Highest 1000 seed weight (3.08) was recorded in plots treated with moringa leaves extract priming while lower seed weight (2.34) were taken from plots treated with non-primed seeds. Similarly, greater seed weight (2.91) was recorded in plots where cutting was stop at 30th April and lower seed weight (2.31) was observed in control plots with no cut.

Table 10. 1000 seed weight (g) of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	2.43	2.31	2.63	2.11	2.46	2.55	2.42 d

10th April	2.45	2.99	2.46	2.20	2.53	2.76	2.57 c
20th April	2.53	2.58	2.40	2.21	3.73	2.77	2.70 b
30th April	2.37	3.19	2.48	3.33	4.14	2.84	3.06 a
10th May	2.43	3.02	2.57	2.39	2.62	2.46	2.58 c
Mean	2.44 d	2.82 b	2.51 d	2.45 d	3.10 a	2.68 c	

LSD (0.05) for Priming = 0.08
LSD (0.05) for Stop cuts = 0.07
LSD (0.05) for Priming × stop cut= *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Biological yield (kg ha^{-1})

Data representing biological yield is given in table 11. Analysis of variance revealed that both seed priming and stop cutting showed significant effect on biological yield of berseem. Similarly, their interaction also showed significant result. Biological yield was highest (4991) in plots primed with moringa leaves extracts while lowest biological yield (3410) was obtained from plots with non-primed seeds. Whereas, higher biological yield (4784) is observed in plots with no cuts while lower biological yield (3236) was obtained in plots when cutting was stop at 10th May.

Table 11. Biological yield (kg ha^{-1}) of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	4067	4317	4503	4780	5670	5370	4784 a
10th April	3165	3513	3447	3942	4885	4568	3920 d
20th April	3539	3896	3796	4217	5089	4761	4216 b
30th April	3388	3744	3648	4134	4924	4499	4056 c
10th May	2890	2367	2257	3603	4389	3913	3236 e
Mean	3410 d	3567 d	3530 d	4135 c	4991 a	4622 b	

LSD (0.05) for Priming = 269
LSD (0.05) for Stop cuts = 246
LSD (0.05) for Priming × stop cut = ns

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Seed yield (kg ha^{-1})

Statistical analysis of data for seed yield is showed in table 12. The data revealed that priming and stop cutting had significant effect on seed yield of berseem. Whereas the interaction between seed priming and cutting also remains significant. Plots treated with moringa leaves extract gives higher seed yield (601) as compared to other priming agents while lower seed yield (449) was obtained from plots with non-primed seeds. However, highest seed yield (653) was recorded in plots where cutting was stop at 30th April while lowest seed yield (395) was obtained from control plots with no cut.

Table 12. Seed yield (kg ha^{-1}) of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	325	415	343	474	427	385	395 e
10th April	428	483	444	548	516	456	479 d
20th April	475	539	494	573	590	536	534 b
30th April	564	621	593	581	695	589	607 a
10th May	453	562	524	497	554	474	511 c
Mean	449 e	524 c	480 d	534 b	556 a	488 d	

LSD (0.05) for Priming = 9
LSD (0.05) for Stop cuts = 8
LSD (0.05) for Priming × stop cut= *

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Harvest index (%)

Data related to harvest index is given in table 13. Statistical analysis of data showed that seed priming had no significant effect on harvest index of berseem while stop cuttings showed significant effect on harvest index of berseem. Similarly, their interaction also showed non-significant effect on harvest index. Highest harvest index (22.74) was recorded in plots when cutting was stop at 10th May while lowest (8.3) was obtained from control plots with no cut. However, higher harvest index (18.72) is observed in plots primed with NaCl while lower harvest index (11.63) was recorded from plots with gibberellic acid priming.

Table 13. Harvest index (%) of berseem as affected by seed priming and number of cuttings.

Stop cuts	Priming agents						Mean
	Control	NaCl	KNO_3	PEG	MLE	GA_3	
No cut	8.00	9.61	7.61	9.92	7.53	7.16	8.30 c
10th April	13.54	13.75	12.89	13.89	10.56	9.98	12.44 bc
20th April	13.42	13.83	13.01	13.59	11.59	11.26	12.78 bc
30th April	16.64	16.59	16.27	14.04	14.12	13.09	15.12 b
10th May	15.66	39.81	39.62	13.78	12.63	12.13	22.27 a
Mean	13.45	18.72	17.88	13.05	11.28	10.72	

LSD (0.05) for Priming = ns
LSD (0.05) for Stop cuts = 6.55
LSD (0.05) for Priming × stop cut= ns

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

DISCUSSION

Seed priming significantly improved emergence m^{-2}, likely due to enhanced metabolic activity and stress tolerance during imbibition, resulting in faster and uniform germination. Similar improvements in emergence and seedling vigor have been reported by Musa et al. (2021), Rasheed et al. (2025), Shakil et al. (2025), and Khan et al. (2025). Stop cutting had no significant effect on emergence, and its interaction with priming was also non-significant. Improved crop establishment through priming reduced weed density by minimizing crop–weed competition, confirming earlier findings (Shoaib et al., 2018; Singh et al., 2019). Cutting treatments did not significantly influence weed population. Seed priming significantly affected days to flowering, generally promoting earlier flowering due to improved physiological efficiency and enzymatic activity (Tufail et al., 2019). However, moringa leaf extract (MLE) delayed flowering, possibly due to zeatin-induced prolongation of vegetative growth (Waqas et al., 2019). Cutting management also influenced flowering, with later cutting extending the vegetative phase and delaying reproductive development (Tufail et al., 2024). Plant height increased significantly under seed priming, particularly with MLE, likely due to growth-promoting hormones such as cytokinin's, consistent with Yadav et al. (2023). Uncut plants attained greater height because of prolonged vegetative growth (Singh et al., 2021). The interaction between priming and stop cutting was significant. Fresh and dry fodder yields were strongly affected by cutting management, with maximum biomass recorded when cutting was stopped on 20th April due to extended vegetative growth. Similar trends were reported by Bakheit et al., 2012). Seed priming, particularly with MLE, further enhanced fodder yield through improved photosynthesis and delayed senescence (Muhammad et al., 2017). Yield components such as heads m^{-2} and seeds $head^{-1}$ significantly improved with seed priming, especially under GA_3 and MLE treatments. GA_3 promotes root growth and reproductive development, enhancing seed formation (Puri et al., 2007). Moderate cutting improved branching and sink capacity, whereas excessive or no cutting reduced performance (Shabbir et al., 2014; Quddus et al., 2014). Thousand seed weight increased significantly under MLE priming due to prolonged leaf activity and improved assimilate translocation during seed filling (Ghulam et al., 2013). Cutting stopped on 30th April produced heavier seeds, while frequent cutting reduced seed development (Salma et al., 2020). Biological yield and seed yield were significantly enhanced by seed priming, with maximum performance under MLE, attributed to improved chlorophyll content and growth regulator activity (Tsioubri et al., 2020). Cutting management also influenced yield, with maximum seed yield obtained when cutting was stopped on 30th April (Abuzaid et al., 2021). Harvest index was mainly affected by cutting treatments, while priming showed a non-significant effect due to proportional increases in seed and biomass yield (Xiong et al., 2020).

Conclusion

Field data were analyzed using Statistics 8.1 software. Moringa leaf extract (MLE) seed priming resulted in the highest emergence (214 m^{-2}), lowest weed density (63 m^{-2}), and maximum fresh (42,750 kg ha^{-1}) and dry fodder yield (4,808 kg ha^{-1}). Stopping cutting on 20th April improved fresh (41,043 kg ha^{-1}) and dry fodder yield (4,348 kg ha^{-1}). The shortest flowering period was observed with KNO_3 priming (144 days) and no cutting (139 days). Plant height and branching increased under MLE priming and no-cut treatments. GA_3 priming produced the highest heads m^{-2} (2,205) and seeds per head (49), while stopping cutting at 30th April enhanced seeds per head (54) and thousand seed weight (3.06 g). Biological and seed yields were highest with MLE priming (4,991 and 556 kg ha^{-1}), whereas stopping cutting at 30th April produced maximum seed yield (607 kg ha^{-1}). Harvest index was highest with stop cutting at 10th May and NaCl priming. Overall, seed priming significantly improved growth, fodder production, and yield components of late-sown berseem. Under Peshawar agro-climatic conditions, MLE seed priming combined with stopping cutting on 20th April is recommended for maximizing fodder and seed yield.

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