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Research Paper

Maximizing seed and fodder production in *Cenchrus* species through foliar spray of growth promoters

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ABSTRACT

An experiment was conducted during 2011 to 2013 at Western Regional Research Station (ICAR-Indian Grassland and Fodder Research Institute), Avikanagar, Rajasthan, for evaluating the effect of foliar spray of different growth-promoters on seed yield and quality in *Cenchrus* species. The experiment was laid in randomized block design with 3 replications under rainfed condition. Foliar sprays of 3 growth-promoters, thiourea (0.25, 0.50 and 0.75%), GA_3 (50, 100 and 150 ppm), KNO_3 (2, 4 and 6%) were applied at panicle-initiation stage on 'IGFRI 3108' cv. of buffel grass (*C. ciliaris* L.) 'CAZRI 392' cv. of birdwood grass (*C. setigerus* Vahl). In *C. ciliaris,* foliar spray of 0.5% thiourea, 100 ppm GA_3 and 4% KNO_3 increased seed yield by 39, 31 and 50% respectively, over the control. Similarly, in *C. setigerus* application of these growth-promoters at the same concentration showed increment in seed yield by 46, 39 and 60%, respectively, over the control. Proportion of spikelets with seed increased significantly by 0.25% thiourea, 50 ppm GA_3 and 2% KNO_3 by 12, 18 and 24%, respectively, in *C. ciliaris,* while in *C. setigerus* 0.5% thiourea, 100 ppm GA_3 and 4% KNO_3 found optimum dose that increased proportion of filled seed by 26, 20 and 31% respectively. The foliar application significantly increased germination and seedling length. Dry fodder yield increased by 0.50% thiourea, 100 ppm GA_3 and 4% KNO_3 with high magnitude, viz. 30, 49 and 41% and 40, 47 and 47% in *C. ciliaris* and *C. setigerus* respectively.

Key words **:** *Cenchrus ciliaris, C. setigerus,* Fodder yield, Pasture, Seed quality, Seed setting, Seed yield

India contributes about 18% world's livestock population, while it has only 0.5% grazing area. The pasture lands covers about 4.0% of geographical area (12 million ha) of the country with high grazing intensity (12.6 ACU/ha). Western India covers about 4.36 lakh km^2 which represents one-fourth of total arid and semi-arid regions of the country and these regions extend over 61% and 13% in Rajasthan, 20% and 9% in Gujarat respectively, of total area of the state. Out of total area of Rajasthan and Gujarat, 40% and 30% area are available as grazing lands and 5.4% and 3.5% under permanent pasture respectively. The prominent range species of this region are *Cenchrus ciliaris*, *C. setigerus*, *Lasiurus sindicus*, *Dichanthium annulatum*, *Chrysopogon fulvus*, *Heteropogon contortus*, *Panicum antidotale* etc. (GoI, New Delhi). They can grow on wide range of soils varying from sandy to harder heavy-textured soils with annual rainfall of 350–800 mm and up to an altitude of 1,000 m. Among different rangeland grasses, they are considered palatable and nutritious grasses for all kinds of grazing animals. They contain high percentage of protein (8–10%) with 60–70% digestibility. After well establishment, these grasses give 5–8 t/ha dry fodder out of 3–4 cuts in a year, depending on availability of soil moisture. Seed-production potential of these grasses is about 60–180 kg/ha.

The over-grazing has resulted in grassland deterioration and desertification. Therefore, rejuvenation/establishment of improved grasslands and systematic utilization of pasture lands would facilitate sustainability of livestock production in western region. Among the various reasons for poor condition of grasslands, one of the reasons is non-availability of seed of range grasses as well as poor quality (low germination and higher empty seeds percentage) of seed which limits in establishment and maintenance of proper plant density of grasslands. Many tropical grasses like *Cenchrus* species produce higher percentage of empty seeds due to poor seed setting in the spikelets (Parihar, 2010). There are some physio-chemical manipulations

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those help in more diversion of source to sink that helps in increasing the proportion of filled seed. This approach may be helpful in increasing the proportion of filled seed in the range grasses. Since grasslands are big in size under rainfed condition, hence application of plant nutrients/ growth promoters through foliar spray may be one of the options to enhance seed yield as well as quality in range grasses. Therefore, the present investigation was undertaken for evaluating the effect of foliar spray of different growth promoters on seed yield and quality in buffel grass (*C. ciliaris*) and birdwood grass (*C. setigerus*).

MATERIALS AND METHODS

The field experiment was conducted during 2011 to 2013 at Western Regional Research Station (Indian Grassland and Fodder Research Institute), Avikanagar (26°18', 37' N and 75°25' 50' E, 326 m above mean sea-level), Rajasthan. There were 2 sets of the experiment with 9 levels of growth-promoters applied to both the prominent grasses of the region. The climate of the Avikanagar is semi-arid, with an average rainfall of 600 mm and mean maximum temperature varied from 40 to 45°C in summer and minimum of from 5 to 6°C in winter. The soil of evaluation site was sandy and light in texture with low water-retention capacity and low organic matter content. Foliar sprays of 3 growth-promoters in different concentrations, viz. thiourea (0.25, 0.50 and 0.75%), GA_3 (50, 100 and 150 ppm), KNO_3 (2, 4 and 6%) were applied at panicle-initiation stage. The variety 'IGFRI 3108' of buffel grass and 'CAZRI 392' of bird wood grass were used as test crop in the experiment. The experiment was laid in randomized block design with 3 replications under rainfed condition. Grass was established during the rainy season (*kharif*) 2011 and observations were recorded for 3 years on the same experiment during *kharif* season. Net plot area was 4 m × 3 m (6 rows of 4 m each were sown at row-to-row and plant-to-plant distance 50 cm). Standard package of practices required for raising a good crop were applied. Fodder and seed yields were recorded on plot basis and converted in t/ha and kg/ha respectively. For recording observation on yield-contributing traits, 5 randomly selected tussocks from each plot were used. The proportion of spikelets filled with seed was observed under X-ray machine at the NBPGR, New Delhi. Dose of X-rays was 26 KVa and distance between seed and X-ray source was 14 cm. One-year-old seed (spikelets) was used for germination test. Hundred spikelets from each treatment for each replication were put between the papers (BP) and placed in the germinator in the dark at 25°C for 10 days (ISTA, 2004). Number of normal seedlings was expressed as germination per cent. Net returns for both the crops were computed on the basis of seed and dry-fodder yield, their prevailing market prices and cost of cultivation. Benefit: cost ratio was computed by dividing the net returns by total cost of cultivation. Pooled analysis of 3 years data (2011 to 2013) was done as per analysis of variance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The foliar spray of different growth-promoters at the panicle-initiation stage increased the seed yield as well as seed quality and forage production enormously in both the grass species, viz. buffel grass (*Cenchrus ciliaris*) and bird wood grass (*C. setigerus*) over the control. Moreover it also enhanced yield-contributing traits significantly. The magnitude of effect of various growth-promoters at different doses varied for different traits in both the species.

Seed yield and contributing traits

Foliar spray of 0.5% thiourea, 100 ppm GA_3 and 4% KNO_3 increased remarkably the seed yield of buffel grass by 39, 31 and 50%, respectively, over the control. The seed yield might have enhanced through 1,000-seed weight which increased by 26, 19 and 36% and number of spikelets/spike which were increased by 25, 24 and 31%, respectively, over the control (Table 1). Similarly in birdwood grass application of these growth-promoters at the same concentration exhibited increment in seed yield by 46, 39 and 60%, respectively, over control. The 1,000-seed weight increased by 25, 22 and 27% and number of spikelets/spike by 23, 23 and 32%, respectively, over control (Table 1). Thus, in general, both the species responded similarly. The next higher dose of all growth-promoters though increased these traits but not significantly as compared to over just lower dose. Dwivedi *et al*. (1991) observed that foliar application of KNO_3 @ 2 kg/ha significantly increased seed yield over the control in buffel grass. The effect was even higher in combination of KNO_3 + urea and KNO_3 + $ZnSO_4$. The increase in yield was associated with efficient synthesis of sugar (26–30%) and its upward translocation to reproductive sites (21–23%). Further, these nutrients increased the number of ears-head with large spike length. Vahid *et al*. (2012) observed that foliar application of GA_3 in maize 'Single Cross 704' at flowering stage increased the grain yield. In other study on maize (Single Cross 124) Amin *et al*. (2013) observed that foliar applications of thiourea significantly increased grain yield, ear length, grains/row and 100-grain weight. Foliar spray of 100 ppm thiourea at 50% flowering in barley also reported significant increment for seed yield, spike length and test weight (Kumawat *et al*., 2013).

Seed-quality parameters

Observation of spikelets under X-ray scanning revealed

Table 1. Effect of foliar spray of growth-promoters on growth, yield attributes, seed and dry fodder yield of buffel grass (*Cenchrus ciliaris*) and birdwood *grass (C. setigerus)* (pooled data of 3 years)

Treatment	Germination (%)		Seedling length (cm)		Plant height (cm)		Tillers/tussock		Spikelets/spike		Proportion of filled seed (%)		1,000-spikelet weight (g)		Seed-yield (kg/ha)		Fodder yield (t/ha)	
	C. ciliaris	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*
Control	16.7 (24.12)	20.8 (27.11)	6.4	6.1	93.7	86.3	26.9	26.3	132.9	107.0	62.6 (52.30)	65.3 (53.88)	1.18	2.89	46.4	90.2	4.4	3.6
Thiourea 0.25%	17.8 (24.98)	22.4 (28.27)	6.9	6.8	102.6	92.6	30.7	30.9	148.0	135.2	69.9 (56.73)	76.5 (61.01)	1.35	3.28	57.0	109.9	5.1	4.3
Thiourea 0.50%	19.3 (26.05)	24.6 (29.73)	7.6	7.3	106.5	98.0	33.0	33.6	165.6	131.4	74.1 (59.39)	82.4 (65.21)	1.49	3.60	64.3	131.7	5.7	5.0
Thiourea 0.75%	20.4 (26.82)	25.7 (30.46)	7.5	7.3	108.2	100.3	34.4	34.0	166.7	135.9	75.6 (60.38)	80.7 (63.97)	1.55	3.65	67.4	140.4	6.2	5.1
GA_3 50 ppm	20.1 (26.66)	23.1 (28.75)	7.1	6.7	108.0	98.9	34.5	33.9	148.5	121.3	73.8 (59.18)	75.2 (60.11)	1.30	3.29	53.4	106.9	5.6	4.6
GA_3 100 ppm	20.5 (26.91)	25.1 (30.08)	7.8	7.4	121.2	109.1	38.2	36.2	164.5	132.1	76.8 (61.21)	78.3 (62.26)	1.42	3.52	60.7	125.8	6.5	5.3
GA_3 150 ppm	20.9 (27.22)	26.4 (30.92)	8.2	7.6	121.8	113.6	40.1	37.6	165.4	134.4	79.8 (63.28)	83.0 (65.66)	1.41	3.47	63.0	139.0	6.8	5.5
KNO_3 2%	18.3 (25.32)	23.3 (28.86)	7.0	6.7	103.3	100.1	33.1	32.7	157.2	128.5	77.7 (61.85)	79.6 (63.12)	1.45	3.41	59.4	117.4	5.3	4.5
KNO_3 4%	19.9 (26.52)	26.9 (31.26)	7.6	7.3	108.1	107.9	36.8	35.6	174.3	141.6	79.1 (62.79)	85.8 (67.83)	1.61	3.68	69.6	144.1	6.2	5.2
KNO_3 6%	21.1 (27.36)	26.1 (30.71)	7.6	7.2	106.7	110.4	37.0	37.2	183.1	146.2	80.5 (63.79)	89.5 (71.07)	1.64	3.89	76.0	159.0	6.1	5.7
SEm±	(0.38)	(0.35)	0.2	0.2	2.8	3.8	1.3	1.4	5.0	3.9	(1.57)	(1.34)	0.04	0.09	2.50	5.80	0.20	0.20
CD (P=0.05)	(1.13)	(1.03)	0.5	0.5	8.0	10.8	3.8	4.08	14.1	11.1	(4.65)	(3.98)	0.12	0.26	6.95	16.4	0.61	0.63

Values in parentheses are transformed arcsine in values

that the proportion of spikelets with seed increased significantly by foliar spray of 0.25% thiourea, 50 ppm GA_3 and 2% KNO_3 by 11.7, 17.9 and 24.1% respectively, over the control in buffel grass, while the next 2 doses also increased it but non-significantly. On the other hand, in bird wooed grass, use of 0.5% thiourea, 100 ppm GA_3 and 4% KNO_3 found suitable dose that increased proportion of filled seed by 26.2, 19.9 and 31.4%, respectively, over the control. The increased proportion of filled seed was further confirmed by seed germination testing under laboratory. Use of 0.5% thiourea, 100 ppm GA_3 and 4% KNO_3 enhanced germination by 15.6, 22.8 and 19.2% and 18.3, 20.7 and 29.3% in buffel and bird wood grass respectively (Table 1). The increase in germination supposed to be owing to increase in proportion of filled seed. Seedling length is other seed-quality parameter which also increased significantly with middle dose of all growth-promoters ranging from 19 to 20% in both the species with more effect of GA_3. Thus, in general, in both the species 4% KNO_3 exhibited better effect for seed quality. Thoithoi Devi *et al*. (2013) reported enhancement in germination of six-month-old hybrid rice seed by application of GA_3, followed by ethrel (12 days after GA_3). Balwinder Kumar *et al.* (2013) reported that foliar application of salicylic acid (50 mg/litre) and KNO_3 (2%) in *Trifolium alexandrinum* recorded the maximum heads/m, seeds/head, 1,000-seed weight, germination percentage and seedling vigour index. Foliar application of boron (400, 800 and 1,200 mg/litre) in *Medicago sativa* during anthesis improved seed germination and increased seed vigour (Dordas, 2006).

Forage yield and its attributes

Fodder yield was recorded after 3 seed pickings. Dry fodder yield increased by foliar spray of 0.50% thiourea, 100 ppm GA_3 and 4% KNO_3 with high magnitude, viz. 30, 49 and 41% and 40, 47 and 47% in buffel and bird wood grass respectively (Table 1). Plant height was increased by 14, 29 and 15% in buffel grass and 14, 26 and 25% in bird wood grass, respectively, over the control. The maximum effect on plant height was exhibited by use of 100 ppm GA_3, followed by 4% KNO_3. The other forage-attributing trait is number of tillers/tussock, which also increased significantly ranging from

Table 2. Economics of production of *C. ciliaris* and *C. setigerus* under the sprays of growth-promoters in semi-arid regions (pooled data of 3 years)

Treatment	Cost of cultivation (× 10^3 ₹/ha)		Net returns (× 10^3 ₹/ha)		Benefit: cost ratio	
	C. ciliaris	*C. setigerus*	*C. ciliaris*	*C. setigerus*	*C. ciliaris*	*C. setigerus*
Control	7.0	8.4	7.3	8.9	1.03	1.06
Thiourea 0.25%	9.6	11.3	11.4	22.0	1.19	1.94
Thiourea 0.50%	10.1	12.3	12.9	26.3	1.27	2.15
Thiourea 0.75%	10.6	12.9	13.1	26.6	1.25	2.07
GA_3 50 ppm	10.1	11.8	10.7	21.4	1.06	1.82
GA_3 100 ppm	10.7	13.2	12.1	25.2	1.13	1.91
GA_3 150 ppm	11.5	14.4	12.6	27.3	1.10	1.89
KNO_3 2%	10.7	12.8	11.9	23.5	1.11	1.83
KNO_3 4%	12.2	15.2	13.9	28.8	1.14	1.89
KNO_3 6%	13.7	17.3	15.4	31.8	1.12	1.84

17 to 42% in both the species with middle dose of all growth-promoters with maximum effect of GA_3. Foliar spray of thiourea (6.6 mM) at anthesis in wheat increased plant height and grain weight (Asthir *et al.*, 2013). This was caused by increase in the total soluble proteins, amino acids and chlorophyll contents. In maize 'Single Cross 124' foliar applications of thiourea significantly increased total dry weight (Amin *et al*., 2013).

Economics

On an average, the maximum net returns of *Cenchrus ciliaris* and *Cenchrus setigerus* were obtained under the spray of KNO_3 followed by thiourea and GA_3 over the control (Table 2). On the other hand, the benefit: cost ratio was found better under the spray of thiourea over GA_3 and KNO_3. Among the concentrations, thiourea 0.50%, GA_3 100 ppm and $KNO_3$4% were found superior to their respective doses of chemicals.

Thus, the foliar spray of thiourea (0.50%), GA_3 (100 ppm) and KNO_3 (4%) are equally effective for enhancing seed yield, as well as quality of seed and forage yield along with their attributing traits. Hence by considering low cost, easy in availability and handling, use of 0.5% thiourea solution at panicle-initiation may be recommended for enhancing quality seed production in *Cenchrus* species.

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