

## SPLIT APPLICATION OF NITROGEN IN DUAL PURPOSE SORGHUM

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### SUMMARY

A field experiment was conducted during *kharif* season of 2018, 2019 and 2020 to study the effect of split application of nitrogen to dual purpose *kharif* sorghum at Centre for Millets, Sardarkrushinagar Dantiwada Agricultural University, Deesa. The experiment was carried out in randomized block design with three replication comprising thirteen treatments *viz.*, T<sub>1</sub> [50 % basal + 50 % split and one split (30 DAS)], T<sub>2</sub> [50 % basal + 50 % split and two split (20 and 40 DAS)], T<sub>3</sub> [50 % basal + 50 % split and three split (20, 40 and 60 DAS)], T<sub>4</sub> [50 % basal + 50 % split and four split (20, 40, 60 and 80 DAS)], T<sub>5</sub> [25 % basal + 75 % split and one split (30 DAS)], T<sub>6</sub> [25 % basal + 75 % split and two split (20 and 40 DAS)], T<sub>7</sub> [25 % basal + 75 % split and three split (20, 40 and 60 DAS)], T<sub>8</sub> [25 % basal + 75 % split and four split (20, 40, 60 and 80 DAS)], T<sub>9</sub> [No basal + 100 % split and one split (30 DAS)], T<sub>10</sub> [No basal + 100 % split and two split (20 and 40 DAS)], T<sub>11</sub> [No basal + 100 % split and three split (20, 40 and 60 DAS)], T<sub>12</sub> [No basal + 100 % split and four split (20, 40, 60 and 80 DAS)] and T<sub>13</sub> (100 % RDN) in which 75 % recommended dose of nitrogen was applied in treatment T<sub>1</sub> to T<sub>12</sub> while in treatment T<sub>13</sub> full dose of nitrogen was applied as a basal. Sorghum under rain-fed environment of North Gujarat with 25 % N (15 kg) as basal and remaining 75 % N (45 kg) in three equal splits at 20, 40 and 60 DAS in addition to recommended dose of phosphorus (40 kg/ha) as basal for obtaining significantly higher number of leaves, leaf length, leaf width, ear head length, grain yield, dry fodder yield and net return with saving of 25 % N.

**Key words:** Dual purpose sorghum, split application of nitrogen, yield, yield attributes, net returns

Livestock population of India is around 306.7 million and it grows up to 1.2 million animals in year (Anon., 2021-2022). In India, the area under sorghum is approximately 7.38 million hectares with an annual production of 8.71 million tones. (Anon., 2021-22). At present, in India 8.6 million hectare of the cultivated area. Green fodder yield 40 to 50 t/ha. Dry matter yield 10-15 t/ha. Demand of green and dry fodder yield 851.3 million tonnes and 530.5 million tonnes respectively and supply of green and dry fodder yield 590.4 million tonnes and 467.6 million tonnes respectively (Anon., 2020). To satisfy the demand of the current level of livestock production and its annual growth in population, the deficit has to be met from either increasing productivity or increasing land area under fodder cultivation or through import.

Sorghum (*Sorghum bicolor*) is one of the important fodder crops which is fast growing, adaptive to varying environmental condition and palatable to the animals. It is being cultivated across the country in both *kharif* and *rabi* season. The productivity of sorghum genotypes is low because of poor management and low resource allocation. Both

deficient and excess application of fertilizers hinders crop performance and pollutes environment. Hence, optimum nutrient supply is a key factor for obtaining higher yield and profits besides sustaining environment.

In sorghum, absence of improved genotype, weed control, plant protection, fertilizer and irrigation resulted in 39, 33, 31, 30 and 22 per cent losses in the fodder productivity as compared to full package of practices (Satpal *et al.*, 2021). Sorghum being an important fodder crops of this region. The application of basal fertilizer along with random and unequal splits dose of N is common practice of fertiliser application by the farmers. However, splitting of N is found better in field crops as splitting of N fertiliser is beneficial to get better yield at same level of N application. Therefore, this experiment is planned to evaluate the split application of nitrogen in sorghum.

### MATERIALS AND METHODS

The field experiment was conducted during *kharif* season in 2018, 2019 and 2020 to study the effect of split application of nitrogen to dual purpose

*kharif* sorghum at Sorghum Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa. The experiment was carried out in randomized block design with three replication comprising thirteen treatments *viz.*, T<sub>1</sub> [50 % basal + 50 % split and one split (30 DAS)], T<sub>2</sub> [50 % basal + 50 % split and two split (20 and 40 DAS)], T<sub>3</sub> [50 % basal + 50 % split and three split (20, 40 and 60 DAS)], T<sub>4</sub> [50 % basal + 50 % split and four split (20, 40, 60 and 80 DAS)], T<sub>5</sub> [25 % basal + 75 % split and one split (30 DAS)], T<sub>6</sub> [25 % basal + 75 % split and two split (20 and 40 DAS)], T<sub>7</sub> [25 % basal + 75 % split and three split (20, 40 and 60 DAS)], T<sub>8</sub> [25 % basal + 75 % split and four split (20, 40, 60 and 80 DAS)], T<sub>9</sub> [No basal + 100 % split and one split (30 DAS)], T<sub>10</sub> [No basal + 100 % split and two split (20 and 40 DAS)], T<sub>11</sub> [No basal + 100 % split and three split (20, 40 and 60 DAS)], T<sub>12</sub> [No basal + 100 % split and four split (20, 40, 60 and 80 DAS)] and T<sub>13</sub> (100 % RDN as a basal). Among the treatments 75 % recommended dose of nitrogen was applied in treatments T<sub>1</sub> to T<sub>12</sub> while in treatment T<sub>13</sub> full dose of nitrogen was applied as basal. Gujarat Jowar 43 variety was taken for experiment. The RDF of sorghum was 80-40 NP kg/ha. The total rainfall received was 235.40 mm during 2018-19, 743.4 during 2019-20 and 679.0 mm during 2020-21, with 28, 41 and 30 rainy days respectively. The average monthly air temperature and relative humidity were almost similar during all the years.

Sources of nitrogen and phosphorus were urea and single super phosphate. Recommended package of practices were followed for raising the crop. Sorghum was sown in the last week of June, the last week of July and first week of July in *Kharif* 2018, *Kharif* 2019 and *Kharif* 2020, respectively and harvested first week of October during *Kharif* 2018 and *Kharif* 2020 while during 2019 was harvested during first week of November. Four lifesaving irrigations (50 mm of each irrigation) was given during 2018, two irrigations during 2019 and three irrigations during 2020 were applied during its entire cropping period. Yield attributes of dual purpose sorghum like grain and dry fodder yield at harvest were recorded. Grain and dry fodder yield of sorghum were recorded from net plot and then expressed in kg/ha.

Economic crops were taking into account the prevailing minimum support price (MSP)/market prices of the crops. Cost of cultivation and net return were worked out by using prevailing market prices of inputs during the period of investigation. Net return was estimated by subtracting total cost of cultivation

from gross return. Benefit-cost ratio (BCR) was worked out by using the following formula. The statistical analysis of data of various characters was done using analysis of variance techniques as suggested by Panse and Sukhatme (1985)

## RESULTS AND DISCUSSION

### *Kharif* 2018

The data presented in Table 1 and Table 2 indicated that application of nitrogen at different days after in form of urea had significant effect on grain and dry fodder yield of sorghum. Significantly higher plant height (252.13 cm) was recorded under treatment T<sub>7</sub> [25 % basal + 75 % split and three split (20, 40 and 60 DAS)] which were statistically at par with all the treatments except T<sub>1</sub>, T<sub>3</sub>, T<sub>6</sub>, T<sub>8</sub> and T<sub>10</sub>. Grain yield (3501 kg/ha) and dry fodder yield (20090 kg/ha) were significantly highest under same treatment *i.e.* T<sub>7</sub>. Maximum net return (₹ 191924/ha) and benefit cost ratio (4.95) was recorded under same treatment *i.e.* T<sub>7</sub> [25 % basal + 75 % split and three split (20, 40 and 60 DAS)]. The results are confirmed with the results reported by Degu *et al.*, (2021).

### *Kharif* 2019

The data presented in Table 1 and Table 2 indicated that significantly higher plant height (259.93 cm) was recorded under treatment T<sub>6</sub> [25 % basal + 75 % split and two split (20 and 40 DAS)] which was statistically at par with T<sub>2</sub>, T<sub>10</sub>, T<sub>3</sub>, T<sub>7</sub> and T<sub>4</sub>. Grain yield and dry fodder yield were not significantly influenced by different treatments but in case of grain yield treatment T<sub>6</sub> recorded higher yield and in case of dry fodder yield T<sub>7</sub> [25 % basal + 75 % split and three split (20, 40 and 60 DAS)] recorded higher yield. Maximum net return and benefit cost ratio was recorded under treatment T<sub>6</sub> [25 % basal + 75 % split and two split (20 and 40 DAS)]. Degu *et al.*, (2021).

### *Kharif* 2020

The data presented in Table 1 and Table 2 indicated that significantly higher plant height was recorded under treatment T<sub>7</sub> [25 % basal + 75 % split and three split (20, 40 and 60 DAS)] which were statistically at par with T<sub>4</sub>, T<sub>3</sub>, T<sub>2</sub> and T<sub>6</sub>. Grain yield and dry fodder yield were significantly higher under same treatment and remain statistically at par with T<sub>2</sub>,

TABLE 1  
Growth attributes of dual sorghum as influenced by different treatments of split application of nitrogen

Treatment	Days to 50% flowering				Plant height at harvest (cm)				No. of leaves/plant			
	2018	2019	2020	Pooled	2018	2019	2020	Pooled	2018	2019	2020	Pooled
T <sub>1</sub>	66	69	63	66	196.20	244.93	308.83	250.0	11.20	10.07	14.47	11.91
T <sub>2</sub>	66	70	64	67	239.33	254.27	327.05	273.55	12.33	11.20	16.53	13.35
T <sub>3</sub>	68	71	65	68	195.87	251.80	328.24	258.64	10.67	10.13	15.53	12.11
T <sub>4</sub>	68	72	66	69	234.80	250.00	333.35	272.72	11.00	10.67	16.20	12.62
T <sub>5</sub>	68	70	66	68	230.93	245.80	306.69	261.14	11.73	10.80	15.33	12.62
T <sub>6</sub>	69	71	63	68	193.20	259.93	323.27	258.80	11.53	10.67	14.73	12.31
T <sub>7</sub>	69	70	61	67	252.13	250.20	340.13	280.82	11.73	12.33	16.60	13.55
T <sub>8</sub>	69	70	63	67	212.27	242.13	304.59	253.00	11.20	10.93	14.87	12.33
T <sub>9</sub>	69	69	63	67	224.40	246.20	283.10	251.23	11.87	10.47	15.40	12.58
T <sub>10</sub>	70	70	64	68	232.67	253.13	318.63	268.14	11.27	10.27	15.87	12.47
T <sub>11</sub>	71	71	63	68	219.73	231.87	319.21	256.94	11.47	9.80	14.87	12.05
T <sub>12</sub>	70	72	64	68	227.07	229.00	319.42	258.50	12.00	10.13	15.07	12.40
T <sub>13</sub>	67	68	65	67	234.73	236.93	294.69	255.45	11.93	10.67	14.73	12.44
S. Em. ±	0.54	0.62	0.75	0.74	9.77	4.17	5.77	8.17	0.26	0.27	0.28	0.28
CD at 5%	1.59	1.82	2.20	NS	28.51	12.18	16.83	NS	0.75	0.79	0.82	0.82
C.V. %	1.37	1.54	2.05	1.66	7.60	2.94	3.16	4.62	3.87	4.43	3.17	3.74
Y × T		1.82		19.67		0.76						

  

Treatment	Leaf length (cm)				Leaf width (cm)				Ear head length (cm)			
	2018	2019	2020	Pooled	2018	2019	2020	Pooled	2018	2019	2020	Pooled
T <sub>1</sub>	66.93	67.83	72.05	68.94	5.03	4.84	7.32	5.73	14.49	14.61	25.39	18.17
T <sub>2</sub>	67.73	68.00	76.89	70.87	5.18	5.23	7.66	6.02	18.44	17.61	28.11	21.39
T <sub>3</sub>	67.07	66.00	78.39	70.48	5.23	5.26	7.63	6.04	17.15	16.53	26.91	20.19
T <sub>4</sub>	63.67	65.53	77.00	68.73	5.26	5.13	7.41	5.93	16.95	16.87	26.01	19.94
T <sub>5</sub>	64.60	69.32	77.38	70.43	5.01	5.01	7.86	5.96	16.32	16.51	27.59	20.14
T <sub>6</sub>	71.20	66.67	77.87	71.91	5.37	5.43	7.87	6.22	20.87	16.95	28.21	22.01
T <sub>7</sub>	70.07	71.29	80.03	73.80	5.43	5.37	7.94	6.24	21.36	17.47	28.92	22.58
T <sub>8</sub>	66.07	66.67	75.93	69.55	5.23	5.23	7.41	5.95	17.20	16.79	25.25	19.75
T <sub>9</sub>	66.60	67.87	77.90	70.79	4.44	5.18	7.59	5.74	16.03	16.64	26.81	19.83
T <sub>10</sub>	69.13	67.21	76.28	70.87	4.77	4.77	7.19	5.58	16.39	17.28	25.450	19.71
T <sub>11</sub>	68.33	66.78	72.65	69.25	5.13	4.44	7.13	5.57	19.08	17.01	25.71	20.60
T <sub>12</sub>	68.40	68.33	77.78	71.50	4.84	5.03	7.82	5.90	19.58	17.21	27.88	21.56
T <sub>13</sub>	68.00	66.39	73.96	69.45	5.25	5.25	7.77	6.09	17.11	16.75	26.11	19.99
S. Em. ±	1.44	0.85	2.13	0.93	0.14	0.14	0.18	0.11	0.50	0.45	0.42	0.57
CD at 5%	NS	2.49	NS	2.62	0.40	0.40	0.53	0.34	1.46	1.32	1.22	1.66
C.V. %	3.70	2.19	4.83	3.85	4.69	4.69	4.16	4.51	4.87	4.66	2.69	3.87
Y × T		NS		0.43		1.29						

T<sub>6</sub>, T<sub>3</sub> and T<sub>10</sub> but in case of dry fodder yield treatment T<sub>6</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>5</sub> T<sub>1</sub> remain statistically at par. Maximum net return and benefit cost ratio (3.21) was recorded under treatment T<sub>7</sub>. Similar results are in confirmation with Degu *et al.*, (2021).

### Pooled results

The data presented in Table 1 and Table 2 indicated that application of nitrogen at different days

after sowing in form of urea had significant effect on number of leaves, leaf length, leaf width, ear head length, grain and dry fodder yield of sorghum. Significantly higher number of leaves, leaf length, leaf width, ear head length, grain and dry fodder yield was recorded under treatment the T<sub>7</sub> [25 % basal + 75 % split and three Split (20, 40 and 60 DAS)]. Maximum net return and benefit cost ratio was recorded under treatment T<sub>7</sub>. Madneh *et al.*, (2014), Dargie *et al* and Abera *et al*, (2020) also reported same type of results.

TABLE 2  
Seed index and yield of dual sorghum as influenced by different treatments of split application of nitrogen

Treatment	Grain yield (kg/ha)				Dry fodder yield (kg/ha)			
	2018	2019	2020	Pooled	2018	2019	2020	Pooled
T <sub>1</sub>	1965 <sup>ef</sup>	1188 <sup>abc</sup>	2198 <sup>bc</sup>	1784 <sup>cd</sup>	13468 <sup>bc</sup>	14590 <sup>a</sup>	15039 <sup>abc</sup>	14366 <sup>c</sup>
T <sub>2</sub>	3081 <sup>b</sup>	1346 <sup>abc</sup>	2505 <sup>ab</sup>	2311 <sup>ab</sup>	16835 <sup>ab</sup>	17957 <sup>a</sup>	15797 <sup>abc</sup>	16863 <sup>ab</sup>
T <sub>3</sub>	2465 <sup>c</sup>	1348 <sup>abc</sup>	2471 <sup>ab</sup>	2095 <sup>bc</sup>	14310 <sup>bc</sup>	16554 <sup>a</sup>	15685 <sup>abc</sup>	15516 <sup>bc</sup>
T <sub>4</sub>	2485 <sup>c</sup>	1286 <sup>abc</sup>	2111 <sup>bcd</sup>	1961 <sup>bcd</sup>	15853 <sup>bc</sup>	16835 <sup>a</sup>	14646 <sup>abc</sup>	15778 <sup>bc</sup>
T <sub>5</sub>	2215 <sup>cde</sup>	1030 <sup>bc</sup>	2230 <sup>abc</sup>	1825 <sup>cd</sup>	13468 <sup>bc</sup>	15432 <sup>a</sup>	15292 <sup>abc</sup>	14731 <sup>bc</sup>
T <sub>6</sub>	1906 <sup>f</sup>	1546 <sup>a</sup>	2504 <sup>ab</sup>	1985 <sup>bcd</sup>	12626 <sup>c</sup>	18519 <sup>a</sup>	16302 <sup>ab</sup>	15816 <sup>bc</sup>
T <sub>7</sub>	3501 <sup>a</sup>	1533 <sup>ab</sup>	2637 <sup>a</sup>	2557 <sup>a</sup>	20090 <sup>a</sup>	18519 <sup>a</sup>	17228 <sup>a</sup>	18612 <sup>a</sup>
T <sub>8</sub>	2025 <sup>ef</sup>	1238 <sup>abc</sup>	1746 <sup>de</sup>	1670 <sup>d</sup>	14871 <sup>bc</sup>	17116 <sup>a</sup>	13692 <sup>bc</sup>	15226 <sup>bc</sup>
T <sub>9</sub>	2034 <sup>def</sup>	1116 <sup>abc</sup>	1955 <sup>cd</sup>	1702 <sup>cd</sup>	14590 <sup>bc</sup>	17116 <sup>a</sup>	13608 <sup>bc</sup>	15105 <sup>bc</sup>
T <sub>10</sub>	1998 <sup>ef</sup>	1154 <sup>abc</sup>	2314 <sup>abc</sup>	1822 <sup>cd</sup>	12907 <sup>bc</sup>	16835 <sup>a</sup>	13496 <sup>c</sup>	14413 <sup>c</sup>
T <sub>11</sub>	2293 <sup>cd</sup>	1255 <sup>abc</sup>	2191 <sup>bc</sup>	1913 <sup>bcd</sup>	14029 <sup>bc</sup>	17116 <sup>a</sup>	13973 <sup>bc</sup>	15039 <sup>bc</sup>
T <sub>12</sub>	2320 <sup>c</sup>	1011 <sup>c</sup>	2105 <sup>bcd</sup>	1812 <sup>cd</sup>	14871 <sup>bc</sup>	14590 <sup>a</sup>	13608 <sup>bc</sup>	14357 <sup>c</sup>
T <sub>13</sub>	2370 <sup>c</sup>	1199 <sup>abc</sup>	1502 <sup>e</sup>	1690 <sup>cd</sup>	12907 <sup>bc</sup>	15993 <sup>a</sup>	13047 <sup>c</sup>	13982 <sup>c</sup>
S. Em. ±	80	148	127	155	1230	1465	810	689
C.V. %	5.89	20.51	10.02	10.90	14.51	15.19	9.53	13.51
Y × T		342		NS				

TABLE 3  
Economics (Pooled)

Treatment	Grain yield (kg/ha)	Dry fodder yield (kg/ha)	Gross return (Rs./ha)	Cost of cultivation (Rs./ha)	Net Return (Rs./ha)	B:C ratio
T <sub>1</sub>	1784	14366	143190	47530	95660	3.01
T <sub>2</sub>	2311	16863	176755	48050	128705	3.68
T <sub>3</sub>	2095	15516	161380	48570	112810	3.32
T <sub>4</sub>	1961	15778	157330	49090	108240	3.20
T <sub>5</sub>	1825	14731	146655	47530	99125	3.09
T <sub>6</sub>	1985	15816	158480	48050	110430	3.30
T <sub>7</sub>	2557	18612	195340	48570	146770	4.02
T <sub>8</sub>	1670	15226	142930	49090	93840	2.91
T <sub>9</sub>	1702	15105	143605	47530	96075	3.02
T <sub>10</sub>	1822	14413	144945	48050	96895	3.02
T <sub>11</sub>	1913	15039	151715	48570	103145	3.12
T <sub>12</sub>	1812	14357	144265	49090	95175	2.94
T <sub>13</sub>	1690	13982	137510	47790	89720	2.88

Selling Price :

Sorghum Grain : Rs. 40/kg

Dry Fodder : Rs. 5/kg

### ECONOMICS

Economics of different treatments (Table 5) showed that maximum gross (Rs. 195340/ha) and net return (Rs. 146770/ha) with BCR of 4.02 was obtained with treatment T<sub>7</sub> [25 % basal + 75 % split and three split (20, 40 and 60 DAS)] through urea

followed by treatment T<sub>2</sub> [50 % basal + 50 % split and two split (20 and 40 DAS)] in pooled results. However, treatment T<sub>13</sub> (100 % RDN) recorded the lowest gross (Rs. 137510/ha) and net returns (1 89720/ha) as well as BCR (2.88). These results are confirmed with the results reported by Degu *et al.*, (2021).

### CONCLUSION

From the results of present research, it can be concluded that in dual purpose *kharif* sorghum cv. Gujarat Juwar 43 apply 60 kg N/ha. Out of this, 25 % N (15 kg) as basal and remaining 75 % N (45 kg) in three equal splits at 20, 40 and 60 DAS in addition to recommended dose of phosphorus (40 kg/ha) as basal for obtaining higher yield and net return with saving of 25 % N.

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