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## Effect of intercropping and nitrogen levels on biometric growth parameters and yield of forage sweet sorghum

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### Abstract

A field experiment was conducted to study the effect of intercropping and nitrogen levels on biometric growth parameters and yield of forage sweet sorghum at AICRP on Sorghum, Main Agricultural Research Station, Dharwad during *kharif* season of 2015. The experiment was laid out on medium black soil in randomized complete block design with fifteen treatments and three replications. The results of the experiment indicated that intercropping of sweet sorghum + horsegram (2:1) with 100 % RDN recorded significantly higher total dry matter production (71.23 g/plant), LAI (7.72), LAD (106.3 days) and NAR (0.0737 g/dm<sup>2</sup>/day<sup>1</sup>) as compared to others. The same treatment produced significantly higher total green and dry forage yield (49.08 and 12.81 t/ha respectively) and LER (1.36) followed by sweet sorghum + horsegram (2:2) with 100 % RDN due to higher growth and yield attributes.

**Keywords:** Intercropping, nitrogen, biometric, forage yield, sweet sorghum

### Introduction

Agriculture and animal husbandry in India are interwoven with the intricate fabric of the society in cultural, religious and economical ways as mixed farming and livestock rearing forms an integral part of rural living. Livestock production is the backbone of Indian agriculture and source of employment in rural areas for centuries. India is having the largest livestock population of 512.05 million. But area under forage crops in India is only 4.9 per cent of total cultivated area with an annual total forage production 866.6 million tonnes (400.6 and 466 million tonnes green and dry respectively), whereas annual forage requirement is 1706 million tonnes (1097 and 609 million tonnes green and dry respectively) to support the existing livestock population (Anon., 2017) <sup>[1]</sup>.

Intercropping is one of the potent means of better utilization of resources and higher fodder production per unit area and time. Quality of dry matter depends on the accumulation of the nutrients specially nitrogen, phosphorus and potassium (Yakari and Gautam, 2001) <sup>[13]</sup>. Forage sorghum is widely used in livestock nutrition for their high dry matter production and low cost, they have low nutritive value due to their poor protein content. Leguminous forage crops are known for their quality, providing supplementary proteins, phosphorus, iron and certain water soluble vitamins (Pareek and Chandra, 2003) <sup>[3]</sup>. They are fed in addition to the bulk forages, usually in smaller amounts. They can be used either to compensate for poor quality bulk forages or they can be used as substitutes for concentrates. Besides, this also improves the fertility status of soil and reduces the nitrogen requirement of companion or succeeding crop in rotation by fixing atmospheric nitrogen through their nodules. Among the leguminous forage crops, cowpea and horsegram are the important short duration high yielding crops well suited for multiple cropping systems. Nitrogen is the most important nutrient for increasing productivity and quality of forage crops. Acceleration of meristematic activity and encouragement of vegetative growth are some of the known effects of nitrogen on fodder sorghum (Siddique, 1989) <sup>[10]</sup>. Increased cropping intensity, use of high yielding varieties and low or no use of organic manures further aggravated this nitrogen deficiency in crops. As forage sorghum is generally cultivated in marginal soils with poor or no fertilization, the yields are very low. There is an ample scope to improve forage yield as well as quality of the forage by the judicious use of nitrogen fertilizers.

Therefore, the present study was under taken to study the effect of intercropping systems and nitrogen levels on biometric growth parameters and forage yield of sweet sorghum.

### Materials and Methods

The field experiment was conducted on medium black soil at AICRP on Sorghum, Main Agricultural Research Station, Dharwad under rainfed conditions during *kharif* season of 2015. The experiment was laid out in randomized complete block design with three replications. The experiment comprised of fifteen treatment combinations of intercropping systems of forage sweet sorghum (CSV-24SS) with two forage legumes cowpea (Swad) and horsegram (Deenanath) in two row ratios (2:1 and 2:2) along with two nitrogen levels (75 and 100 % RDN) and one control (recommended package of practice). The soil of the experimental site had pH 7.3 with low in available N (252 kg/ha) and available P<sub>2</sub>O<sub>5</sub> (19.7 kg/ha) and high in available K<sub>2</sub>O (382.3 kg/ha). The crops were sown on 15<sup>th</sup> June, 2015 at 30 cm rows as per the treatments. Nitrogen, phosphorus and potassium were applied at the rate of 75:50:25 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O per hectare to sorghum and 15:30 kg N:P<sub>2</sub>O<sub>5</sub> per hectare to legumes in the form of urea, diammonium phosphate and muriate of potash. The 50 per cent recommended dose of nitrogen, 100 per cent recommended dose of phosphorus and potassium were applied at the time of sowing. The remaining 50 per cent nitrogen was applied at 30 DAS as top dressing to forage sorghum. The total rainfall received during the crop period was 259.4 mm. The sorghum and legumes crops were harvested from the net plot area at 50% flowering stage. The various growth and yield parameters were recorded as per the standard procedure (Radford, 1967) <sup>[5]</sup>. The green and dry forage yield of sorghum and legume was recorded. The data collected on different parameters were subjected to statistical analysis as described by Panse and Sukhatme (1967) <sup>[2]</sup> for better interpretation of results.

### Results and Discussion

#### Dry matter production and its partitioning

Sole forage sweet sorghum with 100 % RDN recorded significantly higher leaf weight of sorghum (22.07 g/plant) as

compared to sweet sorghum + cowpea (2:2) with 100 % RDN (18.99 g/plant), sweet sorghum + cowpea (2:1) with 75 % RDN (18.25 g/plant), sweet sorghum + cowpea (2:2) with 75 % RDN (18.20 g/plant) and recommended package of practices (17.75 g/plant) and it was on par with rest of the treatments. This was mainly attributed to the maximum dry matter accumulation in leaf which was due to higher leaf area index. The stem weight of sorghum was significantly higher in sole forage sorghum with 100% RDN (52.21 g/plant) as compared to other treatments except sole forage sweet sorghum with 75 % RDN (50.48 g/plant), sweet sorghum + horsegram (2:1) with 100 % RDN (50.02 g/plant) and sweet sorghum + horsegram (2:2) with 100 % RDN (49.04 g/plant) with which it was on par. Significantly higher total dry matter production of sorghum was recorded in sole forage sweet sorghum with 100 % RDN (74.28 g/plant) as compared to other treatments except sole forage sweet sorghum with 75 % RDN (72.02 g/plant), sweet sorghum + horsegram (2:1) with 100 % RDN (71.23 g/plant) and sweet sorghum + horsegram (2:2) with 100 % RDN (69.78 g/plant) with which it was on par. The higher total dry matter production in sole sorghum as compared to intercropping was mainly due to lower intercrop competition for growth resources. The per cent increase in total dry matter production in intercropping of sweet sorghum+horsegram in 2:1 and 2:2 row proportions with 100% N was to an extent of 11.2 and 9.3 respectively. Among the legume crops leaf weight was significantly higher in sole forage cowpea with 100% RDN (9.21 g/plant) as compared to other treatments except sole forage cowpea with 75% RDN (8.63 g/plant). Significantly higher stem weight was recorded in sole forage cowpea with 100% RDN (19.11 g/plant) as compared to treatments except sole forage cowpea with 75% RDN (18.61 g/plant) with which it was on par. Sole forage cowpea with 100% RDN recorded significantly higher total dry weight (28.32 g/plant) as compared to other treatments except sole forage cowpea with 75% RDN (27.24 g/plant) with it was on par (Table-1). This was mainly attributed to the maximum dry weight in leaf which was due to higher leaf area and might be due to better translocation of photosynthesis from source to sink. The results corroborate the findings of Thippeswamy and Alagundagi (2001) <sup>[12]</sup>.

**Table 1:** Dry matter production and its distribution in forage sorghum and legumes at harvest as influenced by different intercropping systems and nitrogen levels

Treatments	Sweet sorghum (g/plant)				Legume (g/plant)		
	Leaf	Stem	Total	% increase over RPP	Leaf	Stem	Total
Sweet sorghum + 75 % RDN	21.54	50.48	72.02	12.2	-	-	-
Cowpea + 75 % RDN	-	-	-	-	8.63	18.61	27.24
Horsegram + 75 % RDN	-	-	-	-	1.90	4.41	6.31
Sweet sorghum + Cowpea (2:1) + 75 % RDN	18.25	47.38	65.63	3.0	6.51	16.41	22.89
Sweet sorghum + Cowpea (2:2) + 75 % RDN	18.20	46.09	64.22	0.9	6.89	16.76	23.65
Sweet sorghum + Horsegram (2:1) + 75 % RDN	19.97	48.11	68.08	6.5	1.07	3.49	4.56
Sweet sorghum + Horsegram (2:2) + 75 % RDN	19.77	47.82	67.43	5.6	1.22	3.67	4.89
Sweet sorghum + 100 % RDN	22.07	52.21	74.28	14.3	-	-	-
Cowpea + 100 % RDN	-	-	-	-	9.21	19.11	28.32
Horsegram + 100 % RDN	-	-	-	-	2.40	4.92	7.32
Sweet sorghum + Cowpea (2:1) + 100 % RDN	19.75	47.70	67.46	6.2	7.29	17.23	24.52
Sweet sorghum + Cowpea (2:2) + 100 % RDN	18.99	47.66	66.66	5.1	8.08	18.05	26.11
Sweet sorghum + Horsegram (2:1) + 100 % RDN	21.21	50.02	71.23	11.2	1.44	3.89	5.33
Sweet sorghum + Horsegram (2:2) + 100 % RDN	20.74	49.04	69.78	9.3	1.79	4.28	6.06
RPP (Mixed cropping of sweet sorghum and cowpea)	17.75	45.48	63.23	-	7.82	17.77	25.59
S. Em.+	0.93	1.26	1.99	-	0.29	0.31	0.55
C. D. (P=0.05)	2.74	3.73	5.87	-	0.84	0.92	1.63

GFY: Green forage yield, DFY: Dry forage yield, RDN: Recommended dose of nitrogen, RPP: Recommended package of practices

### Biometric growth parameters

Sole forage sweet sorghum with 100 % RDN recorded significantly higher LAI of sorghum (8.03) as compared to other treatments except sole forage sweet sorghum with 75 % RDN (7.93), sweet sorghum + horsegram (2:1) with 100 % RDN (7.72) and intercropping of sweet sorghum + horsegram (2:2) with 100 % RDN with which it was on par. In legumes, sole forage cowpea with 100 % RDN recorded significantly higher leaf area index (5.35) as compared to other treatments except sole forage cowpea with 75 % RDN (5.26), intercropping of sweet sorghum + cowpea (2:2) with 100 % RDN (5.13) and recommended package of practices (5.03) with which it was on par (Table-2). This was mainly attributed to the maximum dry matter accumulation in leaf which was due to higher leaf area. Similar results were also reported by Satpal *et al.* (2015)<sup>[9]</sup>.

Significantly higher leaf area duration of sorghum was recorded in sole forage sweet sorghum with 100 % RDN (111.1 days) as compared to other treatments except sole forage sweet sorghum with 75 % RDN (109.1 days) and intercropping of sweet sorghum + horsegram (2:1) with 100 % RDN (106.3 days) with which it was on par. Significantly higher leaf area duration of legumes was recorded in sole forage cowpea with 100 % RDN (76.0 days) as compared to other treatments except sole forage cowpea with 75 % RDN (74.7 days), intercropping of sweet sorghum + cowpea (2:2)

with 100 % RDN (73.1 days) and recommended package of practices (71.7) with which it was on par. Absolute growth rate did not differ significantly due to different treatments in sorghum. In legumes significantly higher absolute growth rate was recorded in sole forage cowpea with 100 % RDN (0.9471 g/day/ plant) as compared to other treatments except sole forage cowpea with 75 % RDN (0.9113 g day/plant), intercropping of sweet sorghum + cowpea (2:2) with 100 % RDN (0.8542 g/day/ plant) and recommended package of practices (0.8460 g/day/plant). Net assimilation rate was significantly higher in sole forage sweet sorghum with 100 % RDN (0.0760 g/dm<sup>2</sup>/day) as compared to other treatments except sole forage sweet sorghum with 75 % RDN (0.0756 g/dm<sup>2</sup>/day), intercropping of sweet sorghum + horsegram (2:1) with 100 % RDN (0.0737 g/dm<sup>2</sup>/ day), sweet sorghum + horsegram (2:2) with 100 % RDN (0.0707 g/dm<sup>2</sup>/day), sweet sorghum + horsegram (2:1) with 75 % RDN (0.0702 g/dm<sup>2</sup>/day) with which it was on par. Significantly higher net assimilation rate was recorded in sweet sorghum + cowpea (2:2) with 100 % RDN (0.0539 g/dm<sup>2</sup> /day) as compared to other treatments except sweet sorghum + cowpea (2:1) with 100 % RDN (0.0525 g/dm<sup>2</sup> /day) and recommended package of practices (0.0501 g/dm<sup>2</sup> /day) with which it was on par (Table-2). These results were in agreement with findings of Ram and Singh (2003)<sup>[6]</sup>.

**Table 2:** Biometric growth parameters of forage sweet sorghum and legumes as influenced by different intercropping systems and nitrogen levels

Treatments	Leaf area index		Leaf area duration (days)		Absolute growth rate (g/day/plant)		Net assimilation rate (g/dm <sup>2</sup> /day <sup>1</sup> )	
	Sorghum	Legume	Sorghum	Legume	Sorghum	Legume	Sorghum	Legume
Sweet sorghum + 75 % RDN	7.93	-	109.1	-	2.19	-	0.0756	-
Cowpea + 75 % RDN	-	5.26	-	74.7	-	0.9113	-	0.0796
Horsegram + 75 % RDN	-	2.77	-	34.1	-	0.2293	-	0.0650
Sweet sorghum + Cowpea (2:1) + 75 % RDN	7.07	4.64	95.7	67.2	1.99	0.7376	0.0654	0.0546
Sweet sorghum + Cowpea (2:2) + 75 % RDN	6.99	4.75	93.9	68.4	1.95	0.7538	0.0640	0.0530
Sweet sorghum + Horsegram (2:1) + 75 % RDN	7.39	2.33	100.7	28.3	2.05	0.1902	0.0702	0.0525
Sweet sorghum + Horsegram (2:2) + 75 % RDN	7.29	2.50	99.2	30.4	2.06	0.1898	0.0675	0.0548
Sweet sorghum + 100 % RDN	8.03	-	111.1	-	2.24	-	0.0760	-
Cowpea + 100 % RDN	-	5.35	-	76.0	-	0.9471	-	0.0930
Horsegram + 100 % RDN	-	3.06	-	37.0	-	0.2689	-	0.0623
Sweet sorghum + Cowpea (2:1) + 100 % RDN	7.23	4.85	98.2	69.6	2.06	0.7844	0.0689	0.0596
Sweet sorghum + Cowpea (2:2) + 100 % RDN	7.13	5.13	96.6	73.1	2.05	0.8542	0.0678	0.0778
Sweet sorghum + Horsegram (2:1) + 100 % RDN	7.72	2.60	106.3	31.7	2.17	0.2080	0.0737	0.0546
Sweet sorghum + Horsegram (2:2) + 100 % RDN	7.63	2.78	103.6	33.6	2.12	0.2202	0.0707	0.0534
RPP (Mixed cropping of sweet sorghum and cowpea)	6.82	5.03	91.9	71.7	1.91	0.8460	0.0637	0.0629
S. Em.+	0.21	0.13	2.1	1.6	1.16	0.038	0.002	0.006
C. D. (P=0.05)	0.62	0.38	6.2	4.6	NS	0.110	0.007	0.017

GFY: Green forage yield, DFY: Dry forage yield, RDN: Recommended dose of nitrogen, RPP: Recommended package of practices

### Yield

Sole forage sweet sorghum with 100 % RDN recorded significantly higher green and dry sorghum forage yield (47.25 and 12.80 t/ha respectively) as compared to other treatments. These results are in conformity with findings of Ramanjaneyulu *et al.* (2010)<sup>[7]</sup>. Among intercropping systems, sweet sorghum + horsegram (2:1) with 100 % RDN recorded significantly higher green and dry sorghum forage yield (42.36 and 11.39 t/ha respectively) as compared to other intercropping systems (Table-3). This was mainly due to

higher plant population of sorghum per unit area as compared to intercropping and higher nitrogen level (100 % RDN). The higher forage yield obtained was due to positive association between growth and yield attributing characters *viz.*, leaf area index and total dry matter production. These results are in agreement with the findings of Patel *et al.* (2008)<sup>[4]</sup>. Green and dry forage yield of forage legumes was significantly higher in sole forage cowpea with 100 % RDN (25.28 and 4.93 t/ha respectively) as compared to other treatments. This could be attributed to higher plant population

of legumes under sole cropping systems which in turn reduced competition for growth resources viz., light, moisture and nutrients and were free from shading effect unlike under intercropping systems. Among the intercropping systems, sweet sorghum + cowpea (2:2) with 100 % RDN recorded significantly higher green and dry legume forage yield (15.51 and 3.03 t/ha respectively) as compared to other intercropping systems except recommended package of practice (13.78 and 2.69 t/ha) with which it was on par (Table-3). This could be mainly attributed to higher cowpea population in intercropping systems (50 per cent plant population in 2:2 row as compared to 2:1) and higher nitrogen level (100 % RDN). These results corroborate the findings of Thippeswamy and Alagundagi (2001)<sup>[12]</sup>.

Sweet sorghum + horsegram with 100 % RDN recorded significantly higher total green and dry forage yield (49.08 and 12.81 t ha<sup>-1</sup> respectively) as compared to other treatments except sweet sorghum + horsegram (2:2) with 100 % RDN (47.57 and 12.35 t/ha respectively) and sole forage sweet sorghum with 100 % RDN (47.24 and 12.80 t/ha respectively)

with which it was on par (Table-3). The higher total forage yield was mainly due to the higher forage yield contribution from base crop sorghum (86.3 per cent in 2:1 and 81.8 per cent in 2:2 row proportions) and more supply of nitrogen (100 % RDN) which helped the crop to grow more vigorously to produce more dry matter. Total forage yield in all the intercropping systems, sole sorghum with two nitrogen levels (100 % and 75 % RDN) and recommended package of practice was superior over sole legumes (cowpea and horsegram). These results are in conformity with findings of Singh *et al.* (2014)<sup>[11]</sup>. Significantly higher land equivalent ratio of 1.43 was observed in intercropping of sweet sorghum + horsegram (2:2) with 75 % RDN as compared to other treatments except sweet sorghum + horsegram (2:2) with 100 % RDN (1.41) and sweet sorghum + horsegram (2:1) with 100 % RDN (1.36) (Table-3). This was mainly due to contribution of green forage yield from sorghum and legume components. These findings are in agreement with the findings of Reza *et al.* (2013)<sup>[8]</sup>.

**Table 3:** Green forage yield, dry forage yield and land equivalent ratio as influenced by different intercropping systems and nitrogen levels

Treatments	Sweet sorghum yield (t/ha)		Legume yield (t/ha)		Total forage yield (t/ha)		Land equivalent ratio (LER)
	GFY	DFY	GFY	DFY	GFY	DFY	
Sweet sorghum + 75 % RDN	43.36	11.72	-	-	43.36	11.72	1.00
Cowpea + 75 % RDN	-	-	21.30	4.16	21.30	4.16	1.00
Horsegram + 75 % RDN	-	-	12.67	2.65	12.67	2.65	1.00
Sweet sorghum + Cowpea (2:1) + 75 % RDN	30.06	8.10	8.10	1.58	38.16	9.69	1.07
Sweet sorghum + Cowpea (2:2) + 75 % RDN	24.40	6.56	13.42	2.62	37.82	9.18	1.20
Sweet sorghum + Horsegram (2:1) + 75 % RDN	38.30	10.27	5.40	1.13	43.71	11.40	1.31
Sweet sorghum + Horsegram (2:2) + 75 % RDN	36.18	9.72	7.64	1.60	43.82	11.32	1.43
Sweet sorghum + 100 % RDN	47.25	12.80	-	-	47.24	12.80	1.00
Cowpea + 100 % RDN	-	-	25.28	4.93	25.28	4.93	1.00
Horsegram + 100 % RDN	-	-	14.76	3.09	14.76	3.09	1.00
Sweet sorghum + Cowpea (2:1) + 100 % RDN	32.50	8.78	8.54	1.67	41.04	10.45	1.03
Sweet sorghum + Cowpea (2:2) + 100 % RDN	26.40	7.11	15.51	3.03	41.91	10.14	1.17
Sweet sorghum + Horsegram (2:1) + 100 % RDN	42.36	11.39	6.72	1.43	49.08	12.81	1.36
Sweet sorghum + Horsegram (2:2) + 100 % RDN	38.89	10.54	8.68	1.81	47.57	12.35	1.41
RPP (Mixed cropping of sweet sorghum and cowpea)	21.66	5.88	13.78	2.69	35.44	8.58	1.02
S. Em. +	0.96	0.26	0.64	0.13	1.20	0.29	0.03
C. D. (P=0.05)	2.83	0.76	1.88	0.37	3.48	0.85	0.08

GFY: Green forage yield, DFY: Dry forage yield, RDN: Recommended dose of nitrogen, RPP: Recommended package of practices

## Conclusion

Based on the results, it may be concluded that the intercropping of sweet sorghum + horsegram (2:1 or 2:2 row proportion) with 100 % recommended dose of nitrogen found optimum over mixed cropping (RPP) to get maximum dry matter production, leaf area index, leaf area duration, net assimilation rate and total forage yield.

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