



## Studies on Standing Crop Biomass and Primary Productivity of Horse Gram in Jharkhand

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### ABSTRACT

The standing crop biomass in different plant compartments was found to be variable with the age of the crop. The total plant biomass of ageing plant indicated a sigmoidal curve in three varieties of Birsa Kulthi-1, Birsa Kulthi-2 and Birsa Kulthi-3. The total plant biomass was recorded to be 115.53 g/m<sup>2</sup> (Birsa Kulthi-1), 92.85 g/m<sup>2</sup> (Birsa Kulthi-2) and 72.42 g/m<sup>2</sup> (Birsa Kulthi-3) at final harvest i.e. 105 days. Contribution of stem and leaves to the total plant biomass has increased between 15 and 90 days. Infl./pod biomass per cent as found to be increasing throughout. Standing dead biomass was maximum 9.40 per cent (Birsa Kulthi-1), 8.97 per cent (Birsa Kulthi-2) and 6.53 per cent (Birsa Kulthi-3) at final harvest i.e. 105 days. Peak values for current increments in biomass were observed at 90 days in Birsa Kulthi-1 and 105 days in Birsa Kulthi-2 and Birsa Kulthi-3. The peak values for net primary productivity were found to be highest at 90 days for Birsa Kulthi-1 and 105 days harvest for Birsa Kulthi-2 and Birsa Kulthi-3.

### KEYWORDS

Birsa Kulthi, Primary productivity, Crop Biomass

### INTRODUCTION

**H**orsegram (*Dolichos biflorus* L.) or Kulthi is native to old world tropics, and is extensively cultivated in dry areas in India, Australia, Myanmar, Sri Lanka and Himalayas. It is one of the rich source proteins to the common man (Singh *et al.*, -2012a). It is also grown to provide feed and fodder for cattle and horses. Horsegram possesses medicinal properties also. Plant is an annual herb, slender, with slightly twining branches, semi-erect, low growing habit 30–50 cm high. Pods are short, 3–5 cm long, linear, with secured beak and 5–7 seeds. Seeds are flattened, rhomboidal 3–6 mm long, light red brown, black or mottled. In India, it occupies 1.88 million ha with a production of 0.89 million tonnes. It is extensively grown in dry areas of Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Gujarat; in northern parts, it is cultivated in Madhya Pradesh, Himachal Pradesh and foot-hills of Uttar Pradesh, West Bengal, Chhotanagpur and Assam hills.

Horsegram or Kulthi is extensively used in south India as feed for cattle and horses in the same ways as other pulses are used in north India. The seeds are cooked before feeding. Stems, leaves and split husk are also used as cattle feed (Singh *et al.*, -2015). Horsegram is a valuable protein supplement to bulky straw fodders (Singh *et al.*, -2012b). The declining diversity in crop species contributing to the world's food supplies has been considered a potential threat to food security (Khoury *et al.*, -2014). and this dependency on few crops for ensuring food and nutritional security has been challenged with a greater need for diversification as potential future crops (Mabhaudhi *et al.*, -2015). Keeping in view the importance of crop in the area, the present study is done to know the standing biomass and primary productivity of Horsegram/Kulthi.

### MATERIAL AND METHODS

The study area was confined to agro-ecosystem situated near east of Hazaribagh town which is 134 km from Ranchi, Jharkhand (23° 55' North latitude and 85° 25' East longitude).

### STANDING CROP BIOMASS

The first sampling of different varieties of Horse gram/ Kulthi *i.e.*, Birsa Kulthi-1, Birsa Kulthi-2 and Birsa Kulthi-3 was done after 15 days of the emergence of seeding. Samplings were taken at the interval between 15 days of two successive samplings. At each sampling date five plants were selected randomly and were dug out individually up to a depth of 30 cm. Monoliths of the sampled plants were washed carefully to remove soil from the root system. Sampled plants were cut out to separate their component parts. Plants were dried in oven at 80°C for 48 hours. The dried samples were weighed. The average dry weight of five plants was estimated and biomass was expressed in g/m<sup>2</sup>. The standard deviation was calculated for all the mean value.

### NET PRIMARY PRODUCTIVITY

The rate of dry matter production by green plants is termed as "gross primary productivity" and the rate of storage of organic matter in the body of producer organisms, *i.e.* green plants, in excess of respiratory break down of potential chemical energy is known as "net primary productivity" (Odum, 1971).

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It was calculated by using the following formula:

$$NPP (g/m^2/day) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,  $W_1$  and  $W_2$  are standing crop biomass at time  $t_1$  and  $t_2$ , respectively.

**RESULTS AND DISCUSSION**

**Standing Crop Biomass**

The standing crop biomass of three varieties of Kulthi such as Birsa Kulthi-1, Birsa Kulthi-2 and Birsa Kulthi-3 was studied and biomass values are shown in [Tables 1](#). Total plant biomass of variety Birsa Kulthi-1, Birsa Kulthi-2 and Birsa Kulthi-3 grown in almost uniform cultural conditions was estimated at 15 days interval for 105 days. The mean total biomass at 15 days of growth was found to be 0.19 g/m<sup>2</sup> which increased gradually upto 115.33 g/m<sup>2</sup> at 105 days. The biomass accumulation at 15 days age interval in different parts of Kulthi variety Birsa Kulthi-1 is given in [Table 1](#). Similarly, in Birsa Kulthi-2 mean total biomass at 15 days of growth was found to be 0.13 g/m<sup>2</sup> which increased gradually upto 92.85 g/m<sup>2</sup> at 105 days. [Table 1](#) further, indicates that the mean total biomass at 15 days of growth was found to be 0.10 g/m<sup>2</sup> which increased gradually up to 72.42 g/m<sup>2</sup> at 105 days in Birsa Kulthi-3. In total, it was found that the dry weight has increased upto 566.20 g/m<sup>2</sup> (Birsa Kulthi-1), 455.78 g/m<sup>2</sup> (Birsa Kulthi-2) and 354.97 g/m<sup>2</sup> (Birsa Kulthi-3) between 15 and 105 days of growth ([Table 1](#)).

The increase in biomass is attributed to the accumulation of photosynthate this is in consonance with the study of [Devi, 2016](#). The decrease in biomass of stem, leaf, root is attributed to senescence. The total stem, leaf and root plant biomass of aging plants indicate a sigmoid curve in all the three varieties. In annuals the growth has been reported to be sigmoidal ([Nath, 1990](#)). Although all the three varieties were grown in almost uniform cultural conditions the inter varieties differences in the biomass accumulation appears to be genetically controlled.

Age (Days)	105	90	75	60	45	30	15		
	33.60±2.68	34.43±2.75	24.66±1.97	14.68±1.15	2.32±0.18	0.41±0.03	0.05±0.01	Birsa Kulthi-1	
	29.83±2.57	32.47±2.63	21.56±1.86	11.68±1.01	1.89±0.16	0.34±0.03	0.03±0.01	Birsa Kulthi-2	Stem
	26.38±2.29	30.81±2.61	18.80±1.63	10.27±0.89	1.57±0.13	0.28±0.02	0.02±0.01	Birsa Kulthi-3	
	17.41±1.39	20.71±1.65	11.71±0.93	8.01±0.64	2.84±0.22	0.72±0.05	0.12±0.01	Birsa Kulthi-1	
	17.37±1.32	17.86±1.54	10.61±0.91	6.70±0.57	2.39±0.20	0.63±0.05	0.09±0.01	Birsa Kulthi-2	Leaf
	12.52±1.08	14.83±1.27	8.45±0.72	5.26±0.45	1.89±0.16	0.51±0.04	0.07±0.01	Birsa Kulthi-3	
	43.74±4.74	20.28±1.62	10.15±0.81	1.58±0.12	-	-	-	Birsa Kulthi-1	
	30.81±4.67	14.57±1.25	6.21±0.53	1.11±0.09	-	-	-	Birsa Kulthi-2	Infl./Pod
	22.19±4.06	10.44±0.87	4.63±0.37	0.66±0.05	-	-	-	Birsa Kulthi-3	
	10.86±0.86	5.83±0.46	-	-	-	-	-	Birsa Kulthi-1	Standing dead
	8.33±0.71	4.38±0.37	-	-	-	-	-	Birsa Kulthi-2	
	4.73±0.32	2.02±0.01	-	-	-	-	-	Birsa Kulthi-3	
	105.61±9.67	81.25±6.48	46.52±3.71	24.27±1.91	5.16±0.40	1.13±0.08	0.17±0.02	Birsa Kulthi-1	Total
	84.34±9.27	69.28±5.79	38.38±3.30	19.49±1.67	4.28±0.36	0.97±0.08	0.12±0.02	Birsa Kulthi-2	
	65.82±7.75	58.10±4.76	31.88±2.72	16.19±1.39	3.46±0.29	0.79±0.06	0.09±0.02	Birsa Kulthi-3	
	9.92±0.79	11.26±0.90	4.99±0.39	2.64±0.21	0.73±0.05	0.19±0.01	0.02±0.01	Birsa Kulthi-1	
	8.51±0.73	9.19±0.79	4.31±0.37	2.06±0.17	0.59±0.05	0.14±0.01	0.01±0.01	Birsa Kulthi-2	Root (R)
	6.60±0.55	7.19±0.60	3.99±0.33	1.66±0.13	0.53±0.04	0.12±0.05	0.01±0.01	Birsa Kulthi-3	
	115.53±10.46	92.51±7.38	51.51±4.10	26.91±2.12	5.89±0.45	1.32±0.09	0.19±0.02	Birsa Kulthi-1	
	92.85±10.00	78.47±6.58	42.69±3.67	21.55±1.84	4.87±0.41	1.11±0.09	0.13±0.02	Birsa Kulthi-2	Shoot+Root
	72.42±8.30	65.29±5.36	35.87±3.05	17.85±1.52	3.99±0.33	0.91±0.07	0.10±0.02	Birsa Kulthi-3	

**Table 1:** Mean standing crop biomass (g/m<sup>2</sup>±SD) of different varieties of horse gram / Kulthi

### Per Cent Contribution Of Plant Parts

The per cent contribution of each part i.e. stem, leaf, infl./pod. Standing dead and root to the total plant biomass of three varieties of horse gram/ Kulthi, i.e. Birsa Kulthi-1, Birsa Kulthi-2 and Birsa Kulthi-3 has been presented in Table 2. The per cent contribution by stem to total biomass was 26.32% at 15 days which had increased to 47.87% at 75 days and thereafter decreased to 29.08% at 105 days of growth period in

Kulthi-1, whereas, the per cent contribution by stem to total biomass in Birsa Kulthi-2 was 23.08 at 15 days which had increased to 54.20% at 60 days and thereafter decreased to 32.13% at 105 days of growth period. Similarly, in Kulthi-3, the per cent contribution by stem to total biomass was 20% at 15 days which had increased to 57.53% at 60 days and thereafter decreased to 36.43% at 105 days of growth period.

**Table 2:** Percent contribution of different part to the total plant biomass in different varieties of horse gram

Age (Days)	Stem			Leaf			Infl./Pod			Standing dead			Root		
	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3
15	26.32	23.08	20.00	63.15	69.23	70.00	-	-	-	-	-	-	10.53	7.69	10.00
30	31.06	30.63	30.77	54.55	56.76	56.04	-	-	-	-	-	-	14.39	12.61	13.19
45	39.39	38.81	39.35	48.22	49.08	47.37	-	-	-	-	-	-	12.39	12.11	13.28
60	54.55	54.20	57.53	29.77	31.09	29.47	5.87	5.15	3.70	-	-	-	9.81	9.56	9.30
75	47.87	50.50	52.41	22.73	24.85	23.56	19.70	14.55	12.91	-	-	-	9.69	10.10	11.12
90	37.22	41.37	47.19	22.39	22.76	22.71	21.92	18.57	15.99	6.30	5.58	3.09	12.17	11.71	11.01
105	29.08	32.13	36.43	15.07	16.55	17.29	37.86	33.18	30.64	9.40	8.97	6.53	8.59	9.17	9.11

### Current Increments In Biomass

The mean and current increment in total plant biomass of different varieties of Kulthi i.e. Birsa Kulthi-1, Birsa Kulthi-2 and Birsa Kulthi-3 have been shown in Table 3. Mean increment in total plant biomass of Kulthi followed an increasing trend i.e. from 0.012 g/m<sup>2</sup>/day to 1.027 g/m<sup>2</sup>/day between 15 and 105 days in variety Birsa Kulthi-1. The mean increment rate in Birsa Kulthi-2 was 0.009 g/m<sup>2</sup>/day to 0.884 g/m<sup>2</sup>/day between 15 and 105 days. The mean increment rate in Birsa Kulthi-3 was 0.007 g/m<sup>2</sup>/day at 15 days of growth which had followed an increasing trend reaching to a

maximum 0.69 g/m<sup>2</sup>/day at 105 days of growth. The current increment rate of total plant biomass of Birsa Kulthi-1 followed an increasing trend i.e. from 0.075 g/m<sup>2</sup>/day to 2.733 g/m<sup>2</sup>/day between 30 days and 90 days which later on decreased to 1.535 g/m<sup>2</sup>/day at 105 days. The current increment rate of total biomass ranged from 0.065 g/m<sup>2</sup>/day to 0.959 g/m<sup>2</sup>/day between 30 and 105 days in Birsa Kulthi-2. In Birsa Kulthi-3 the current increment rate of total biomass ranged from 0.054 g/m<sup>2</sup>/day to 0.475 g/m<sup>2</sup>/day between 30 and 105 days.

**Table 3:** Total plant biomass, mean and current increment in biomass of different varieties of horse gram / Kulthi

Age (Days)	Total Biomass (g/m <sup>2</sup> )			Mean increment in biomass (g/m <sup>2</sup> /day)			Current increment in biomass (g/m <sup>2</sup> /day)		
	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3
15	0.19	0.13	0.10	0.012	0.009	0.007	-	-	-
30	1.32	1.11	0.91	0.044	0.037	0.030	0.075	0.065	0.054
45	5.89	4.87	3.99	0.131	0.108	0.089	0.305	0.250	0.205
60	26.911	21.55	17.85	0.448	0.359	0.298	1.401	1.112	0.924
75	51.51	42.69	35.87	0.687	0.569	0.478	1.640	1.409	1.201
90	92.51	78.47	65.29	1.027	0.871	0.724	2.733	2.385	1.961
105	115.53	92.85	72.42	1.100	0.884	0.690	1.535	0.959	0.475

### Net Primary Productivity (NPP)

Net primary productivity of plant parts of three varieties i.e., Birsa Kulthi-1, Birsa Kulthi-2 and Birsa Kulthi-3 of Kulthi of 105 days has been presented in Table 4. It was found that the net primary productivity has increased upto 2.753 g/m<sup>2</sup>/day

(Birsa Kulthi-1) at 90 days, 2.385 g/m<sup>2</sup>/day (Birsa Kulthi-2) at 90 days and 1.961 g/m<sup>2</sup>/day (Birsa Kulthi-3) at 90 days of growth (Tables 3). The initial increase of net primary productivity is indicative of high rate of photosynthesis and storage of materials which is associated with high leaf area

index. The decline in productivity after 90 days is attributed to the increase in the leaf area index and senescence (Khokhar and Pandey, 1976; Singh, 1971; Kumar, 1984; Pandey and

Nath, 1990; Pandey and Kumari, 1995; Singh, *et al.* 1999; Pandey *et al.* 2002, Pandey *et al.* 2003; Pathak *et al.*, 2004; Choudhary *et al.*, 2005, Prashant *et al.*, 2008 and Kumar 2010).

**Table 4:** Mean net primary productivity (g/m<sup>2</sup>/day) of different varieties of horse gram / Kulthi

Age (Days)	Stem			Leaf			Infl./Pod			Standing dead			Root		
	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3	Birsa Kulthi-1	Birsa Kulthi-2	Birsa Kulthi-3
15	0.003	0.002	0.001	0.008	0.006	0.005	-	-	-	-	-	-	0.001	0.001	0.001
30	0.024	0.021	0.017	0.040	0.036	0.029	-	-	-	-	-	-	0.011	0.009	0.007
45	0.127	0.103	0.086	0.141	0.117	0.092	-	-	-	-	-	-	0.036	0.030	0.027
60	0.824	0.653	0.580	0.345	0.287	0.225	0.026	0.019	0.011	-	-	-	0.127	0.098	0.075
75	0.665	0.659	0.569	0.247	0.261	0.213	0.571	0.340	0.265	-	-	-	0.157	0.150	0.155
90	0.651	0.727	0.801	0.600	0.483	0.425	0.675	0.557	0.387	0.064	0.049	0.022	0.418	0.325	0.213
105	-0.055	-0.176	-0.295	-0.220	-0.166	-0.154	1.564	1.082	0.783	0.335	0.263	0.181	-0.089	-0.045	-0.039

## CONCLUSION

The above studies concluded that the Birsa Kulthi-1 variety of Kulthi (*Dolichos biflorus* L.) is ecologically suitable for

cultivation in the vicinity of the agro climatic condition of Hazaribagh, Jharkhand.

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