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## Effect of green and brown manuring on productivity of maize-wheat cropping system under UKP command

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### Abstract

A field experiment was conducted at Agricultural Research Station, Bheemarayanagudi during *kharif* and *rabi* seasons of 2013-14 and 2014-15 to study the effect of green and brown manuring on the productivity of maize – wheat cropping system under UKP command. The results indicated that the grain yield of maize ( $55.35 \text{ q ha}^{-1}$ ) was significantly higher with sunnhemp as green manuring in 1:2 row proportions compared to sole maize ( $60 \text{ cm} \times 20 \text{ cm}$ ) without manuring ( $43.85 \text{ q ha}^{-1}$ ) and it was found on par with sunnhemp, cowpea and dhaincha as brown manuring in 1:1 and 1: 2 row proportions in maize. The residual effect of legume species used as green and brown manuring in preceding maize was affected significantly on succeeding wheat crop. Sunnhemp as green manuring in 1:2 row proportion registered significantly higher grain yield and straw yield of wheat ( $38.45 \text{ q ha}^{-1}$  and  $70.23 \text{ q ha}^{-1}$ , respectively.) and it was on par with sunnhemp as brown manuring in 1:2 row proportion. The lowest grain yield ( $18.35 \text{ q ha}^{-1}$ ) and straw yield ( $36.4 \text{ q ha}^{-1}$ ) were recorded in sole maize plot ( $60 \text{ cm} \times 20 \text{ cm}$ ) without manuring in preceding season. The growth and yield attributing parameters of both the crops were also followed same trend. Varying levels of N did not vary on the performance of wheat. However, higher growth, yield and yield parameters of wheat were recorded in 125% RDN. The net returns also differed significantly among the green and brown manuring practices under maize – wheat cropping system. Sunnhemp as green manuring in 1:2 row proportion (Rs.89,476  $\text{ha}^{-1}$ ) followed by sunnhemp as brown manuring 1:2 row proportions (Rs. 85,820  $\text{ha}^{-1}$ ) and sunnhemp as green manuring in 1:1 row proportions (Rs. 84,575  $\text{ha}^{-1}$ ) were recorded significantly higher net returns. The lowest net returns (Rs. 45,735  $\text{ha}^{-1}$ ) were recorded in sole maize ( $60 \text{ cm} \times 20 \text{ cm}$ ) - wheat sequence. The different nitrogen levels did not differ.

**Keywords:** brown manuring, green manuring, productivity, residual effect, succeeding crop

### Introduction

The Upper Krishna and Tunga Bhadra Projects are the largest irrigation projects in India and also in the state of Karnataka. Rice-Rice is the predominant cropping system being adopted by the farmers long back in these commands. At present, the system being practiced is creating lot of problems with respect to sustainability in crop production and lands are increasingly becoming unproductive. Of the several options available, adoption of alternate novel crop rotation appears to be promising. Maize has become an alternate crop to be integrated in rice-rice system replacing one rice crop especially during winter or replacing rice - rice by alternate and profitable system involving maize - wheat/chickpea sequence in the command. Such cropping system needs investigation to explore the possibility of new concepts of agriculture viz., green manuring, brown manuring, conservation agriculture, crop nutrition through target yield approach etc.

Green manuring is a renewable source of input for building up soil fertility and supplementing plant nutrients contained in the biomass. Such biomass can be obtained either by growing *in situ* and incorporated or grown elsewhere and brought in for incorporation in the field as green manuring. However such practice is not popular among the farming community particularly in arable field crops and cropping systems. This is because farmer neither gets enough window in the growing season to grow a green manure crops nor has enough financial resources to spend on labours. Never the less it can be popularized as a low cost effective technology to save on fertilizer and other inputs.

At present, a new concept called brown manuring technique is gaining popularity in rice ecosystem. Brown manuring is the practice to reduce weed pressure, as brown manuring acts as a cover crop in suppressing weed growth effectively at the initial growth stage (Kumar and Mukharjee, 2011) [6]. The post emergence herbicidal spray on green manure leaves results in loss of chlorophyll in leaves leading to browning and hence the same is referred brown manuring (Tanwar *et al.*, 2010) [12]. It can be achieved through raising green manure crops such as *Sesbania* (dhaincha), sunnhemp etc., as inter crop and killing the same later by application of post emergence herbicides. The suppressed residue as manure is allowed to remain in the field. But at the same time its use is very much required to enhance the sustained accumulation by improving the soil fertility and supplementing the plant nutrients in arable crops practicing cereal-cereal and cereal-legume cropping systems in rainfed as well as irrigated condition.

Therefore, an investigation was undertaken to study the effect of green and brown manuring on the productivity of maize – wheat cropping system under UKP command.

### Material and Methods

A field experiment was conducted during *kharif* and *rabi* seasons of 2013-14 and 2014-15 at Agricultural Research Station, Bheemarayanagudi, University of Agricultural Sciences, Raichur, Karnataka. The soil of the experimental site was medium deep black soil with 7.80 pH. The soil was low in available nitrogen (243 kg ha<sup>-1</sup>), high in available phosphorus (49 kg ha<sup>-1</sup>) and high in available potassium (337 kg ha<sup>-1</sup>). The organic carbon content of the soil was low (0.43%). The Agricultural Research Station represents the UKP command where in rice - rice, chilli and cotton are the predominant crops. The rainfall during cropping seasons in the year 2013 - 14 and 2014 - 15 received 759 mm and 646 mm respectively. The experiment was laid out in a Randomized Complete Block Design consisting of nine treatments namely M<sub>1</sub> - Control (60 cm x 20 cm) as sole maize, M<sub>2</sub> - Maize + sunnhemp as green manuring (1:1), M<sub>3</sub> - Maize + sunnhemp as green manuring (1:2), M<sub>4</sub> - Maize + sunnhemp as brown manuring (1:1), M<sub>5</sub> - Maize + sunnhemp as brown manuring (1:2), M<sub>6</sub> - Maize + cowpea as brown manuring (1:1), M<sub>7</sub> - Maize + cowpea as brown manuring (1:2), M<sub>8</sub> - Maize + dhaincha as brown manuring (1:1), M<sub>9</sub> - Maize + dhaincha as brown manuring (1:2) during *kharif* season. During *rabi* season, these nine treatments become main plots and sub plots consist of three N levels (75, 100 and 125% RDN) to wheat for which, split plot design was laid out in three replications. The hybrid 900M was used for maize and the variety DWR 198 was used for wheat. The recommended dose of fertilizer 150: 75: 37.5 NPK ha<sup>-1</sup> was used for maize. The fertilizers were applied to wheat as per the treatments. Pre emergent herbicide pendimethalin 30 EC @ 2.5 kg ha<sup>-1</sup> was used to control weeds in initial stage in maize intercropped with green manure crops. Post emergent herbicide 2, 4 - D 80 % @ 1.25 kg ha<sup>-1</sup> was used for suppressing the green manure crops and incorporated them as brown manure after harvest of maize in the place where green manure was grown. Other agronomic practices were followed commonly in all the treatments as per the recommendations.

### Results and Discussion

#### Effect of green and brown manuring of legume species on maize

The grain and stover yield of maize did not differ due to green and brown manuring treatments during 2013-14 and differed

significantly during 2014-15. This clearly indicated that legumes have positive influence on maize yields when grown as intercrops for green manuring than sole maize. Among all the treatments in the investigation, the green manuring treatments maize + sunnhemp as GM in 1:2 row proportion (M<sub>3</sub>) followed by maize + sunnhemp as GM in 1:1 row proportion recorded the highest grain yield of maize of 55.35 and 53.37q ha<sup>-1</sup> respectively. The increase in grain yield of maize intercropped with sunnhemp in 1:1 and 1:2 row proportions for green manuring purpose was 23.96 per cent over sole maize. Dasaraddi (1998) [2], Nooli and Chittapur (2001) [7] and Jat *et al.* (2010) [5] also reported similar results. Among different brown manuring practices, the treatment maize + sunnhemp as BM in 1:2 row proportion recorded higher grain and stover yield (53.40 q ha<sup>-1</sup> and 67.00 q ha<sup>-1</sup> respectively) followed by maize + sunnhemp as BM in 1:1 row proportion, maize + cowpea as BM in 1:1 row proportion, maize + dhaincha as BM in 1:1 row proportion and maize + dhaincha as BM in 1:2 proportion. All these treatments were on par with each other and also with maize + sunnhemp as GM in 1:2 row proportions. Further, all these treatments increased the grain yields of maize by 21.78, 19.54, 13.79, 15.89, 9.87 and 11.13 per cent respectively over sole maize (60 cm x 20 cm) which recorded the lowest grain and stover yield (43.85 q ha<sup>-1</sup> and 50.18 q ha<sup>-1</sup> respectively). The results are in conformity with the findings of Aslam *et al.* (2008) [1], Sharma *et al.* (2008) [11] and Satyaprakash and Phoolchand, (2011) [10]. The improvement in grain and stover yield of maize in association with sunnhemp, cowpea and dhaincha grown as intercrops in 1:1 and 1:2 row proportions for green and brown manuring may be further attributed to favourable effect on growth components like plant height, leaf area index and TDMP and yield components such as cob length, cob girth, and number of grains and 100-seed weight. Similar findings were also reported by Ramachandran *et al.* (2012) [8]. This result was further corroborated with the findings of Samar Singh *et al.* (2007) [9] and Kumar and Mukharjee (2011) [6]. Harvest index did not differ due to the treatments.

#### Effect of green and brown manuring of legume species on succeeding wheat

With respect to green manuring, sunnhemp in 1:1 and 1:2 row proportion recorded 50.12 and 52.27 per cent higher grain yield of wheat respectively over without green manuring. The findings are in conformity with the findings of Dasaraddi (1998) [2]. Further, this result also corroborated with the findings of Nooli and Chittapur (2001) [7] who studied in maize - safflower sequence cropping. With respect to brown manuring techniques, the maximum grain yield of wheat with brown manuring of sunnhemp in 1:1 (35.71 q ha<sup>-1</sup>) and 1:2 row proportions in preceding maize (37.79 q ha<sup>-1</sup>) was noticed. The brown manuring of cowpea grown in 1:1 and 1:2 row proportions in preceding maize was found to be next best treatments. All these treatments recorded significantly higher grain yield over yield obtained with brown manuring of dhaincha in 1:1(25.62 q ha<sup>-1</sup>) and 1:2 (27.56 q ha<sup>-1</sup>) row proportions in preceding maize.

Brown manuring of sunnhemp in 1:1 and 1:2 row proportions recorded 51.44 and 48.61 per cent higher grain yield of wheat over control plot. While brown manuring of cowpea in 1:1 and 1:2 row proportion recorded 42.75 and 46.84 per cent higher yield than control plot. While, brown manuring of dhaincha in maize failed to give satisfactory yield levels of wheat. The information on the effect of brown manuring on

succeeding crop is very meager. However, similar kind of influence on succeeding crop was observed with green manuring practice in *kharif* crop. The increase in grain yield could be attributed to numerically higher yield components such as number of tillers, number of grains, grain weight and test weight as affected by residual effect of brown manuring. Grewal *et al.* (1992) [4] studied the response of wheat to residual effect of green manuring as much as 0.5 t ha<sup>-1</sup>. Thus, green manuring augmented total productivity of maize - wheat system by 2.1 t ha<sup>-1</sup>. The findings of Gangawar *et al.* (2004) [3] also confirmed closely with the findings of Jat *et al.* (2010) [5] who observed that the residual effect of sesbania

green manuring + wheat straw and sesbania green manuring alone used in preceding maize affected significantly the growth and yield of succeeding wheat. The increase in the grain yield of wheat might be attributed due to increased plant height, leaf area index, total dry matter production, number of effective tillers, and number of grains per spike and test weight. Harvest index did not differ due to the treatments. Different nitrogen levels to wheat crop had no significant difference. Non significant differences for grain and straw yield of wheat were recorded due to interaction of green and brown manuring of legume species and various nitrogen levels.

**Table 1:** Growth and yield parameters of maize and wheat as influenced by different green and brown manuring practices and nitrogen levels under maize – wheat cropping system (Mean of two years)

Treatment	Maize							Wheat					
	Plant height (cm)	Leaf area index	TDMP (g plant <sup>-1</sup> )	Cob length (cm)	Cob girth (cm)	Grains per cob	Test weight (g)	Plant height (cm)	Leaf area index	TDMP (g plant <sup>-1</sup> )	No of effective tillers	Grains spike <sup>-1</sup>	Test weight (g)
<b>Main plots (M)</b>													
M <sub>1</sub> – Maize alone (60 cm x 20 cm)	160.53	3.22	288.88	11.47	10.82	272.49	20.30	68.17	0.89	155.49	164.16	30.69	27.99
M <sub>2</sub> - Maize + Sunnhemp as GM (1:1)	188.32	4.22	351.67	13.50	12.98	386.88	24.77	89.41	1.44	195.52	273.03	40.25	40.97
M <sub>3</sub> - Maize + Sunnhemp as GM (1:2)	192.00	4.31	365.17	15.10	14.07	434.53	25.43	98.53	1.59	210.42	316.62	46.13	44.04
M <sub>4</sub> - Maize + Sunnhemp as BM (1:1)	180.53	4.07	348.82	13.13	12.50	356.51	24.73	86.64	1.35	192.39	251.80	38.11	39.85
M <sub>5</sub> - Maize + Sunnhemp as BM (1:2)	188.58	4.24	360.79	14.42	13.33	416.53	25.33	95.48	1.50	203.79	286.73	43.03	41.81
M <sub>6</sub> - Maize + Cowpea as BM (1:1)	177.83	3.82	329.20	12.73	11.90	326.63	23.97	82.44	1.23	181.68	226.01	36.27	36.56
M <sub>7</sub> - Maize + Cowpea as BM (1:2)	178.63	3.90	334.75	12.90	12.18	348.53	24.15	84.46	1.31	187.48	241.06	37.35	37.69
M <sub>8</sub> - Maize + Dhaincha as BM (1:1)	173.77	3.58	316.67	12.08	11.75	312.67	22.85	76.97	1.15	165.05	201.92	32.53	30.24
M <sub>9</sub> - Maize + Dhaincha as BM (1:2)	175.58	3.67	323.57	12.50	11.88	318.30	23.22	79.26	1.21	176.42	213.35	34.71	35.36
S.Em±	6.28	0.21	10.08	0.89	0.52	21.25	0.54	2.37	0.06	4.93	7.10	1.30	1.55
CD (P=0.05)	15.70	0.62	30.49	2.20	1.57	64.27	1.63	7.16	0.18	14.90	21.46	3.94	2.19
<b>Sub plots (N)</b>													
N <sub>1</sub> - 75 % RDN	-	-	-	-	-	-	-	83.41	1.17	182.97	235.10	36.58	35.81
N <sub>2</sub> - 100 % RDN	-	-	-	-	-	-	-	84.35	1.29	185.74	239.97	37.79	37.42
N <sub>3</sub> - 125 % RDN	-	-	-	-	-	-	-	86.02	1.43	187.38	248.82	38.65	38.28
S.Em±	-	-	-	-	-	-	-	1.53	0.03	3.41	2.71	0.53	0.96
CD (P=0.05)	-	-	-	-	-	-	-	NS	0.09	NS	7.81	1.52	NS
Interaction (M x N)	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS

**Table 2:** Grain yield, stover yield and harvest index of maize as influenced by different green and brown manuring practices and N levels in maize - wheat cropping system

Treatment	Maize								
	Grain yield (q ha <sup>-1</sup> )			Stover yield (q ha <sup>-1</sup> )			Harvest index		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
<b>Main plots (M)</b>									
M <sub>1</sub>	53.83	33.87	43.85	62.50	37.87	50.18	0.46	0.47	0.47
M <sub>2</sub>	56.70	50.03	53.37	71.40	59.47	65.43	0.44	0.46	0.45
M <sub>3</sub>	57.77	52.93	55.35	73.80	66.67	70.23	0.44	0.45	0.44
M <sub>4</sub>	56.70	48.13	52.42	70.43	58.93	64.68	0.45	0.46	0.45
M <sub>5</sub>	56.77	50.03	53.40	71.73	62.27	67.00	0.44	0.45	0.44
M <sub>6</sub>	55.33	44.47	49.90	67.40	53.96	60.68	0.45	0.46	0.45
M <sub>7</sub>	55.57	46.07	50.82	68.00	56.27	62.13	0.45	0.45	0.45
M <sub>8</sub>	54.53	41.83	48.18	63.43	49.87	56.65	0.46	0.46	0.46
M <sub>9</sub>	55.13	42.33	48.73	65.43	50.67	58.05	0.46	0.46	0.46
S.Em±	3.96	3.51	2.63	4.47	4.94	3.16	0.03	0.02	0.02
CD (P=0.05)	NS	10.62	6.83	NS	14.95	9.57	NS	NS	NS
<b>Sub plots (N)</b>									
N <sub>1</sub>	-	-	-	-	-	-	-	-	-
N <sub>2</sub>	-	-	-	-	-	-	-	-	-
N <sub>3</sub>	-	-	-	-	-	-	-	-	-
S.Em±	-	-	-	-	-	-	-	-	-
CD (P=0.05)	-	-	-	-	-	-	-	-	-
Interaction (M x N)	-	-	-	-	-	-	-	-	-

**Table 2:** Grain yield, straw yield and harvest index of wheat as influenced by different green and brown manuring practices and N levels in maize - wheat cropping system

Treatment	Wheat								
	Grain yield (q ha <sup>-1</sup> )			Straw yield (q ha <sup>-1</sup> )			Harvest index		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
<b>Main plots (M)</b>									
M <sub>1</sub>	20.13	16.57	18.35	36.37	36.62	36.49	0.36	0.31	0.34
M <sub>2</sub>	38.67	34.91	36.79	69.26	65.31	67.28	0.35	0.35	0.35
M <sub>3</sub>	40.13	36.77	38.45	72.01	68.46	70.23	0.36	0.35	0.35
M <sub>4</sub>	37.23	34.18	35.71	67.28	63.54	64.41	0.36	0.35	0.35
M <sub>5</sub>	39.58	36.01	37.79	69.90	66.48	68.19	0.36	0.35	0.36
M <sub>6</sub>	34.20	29.90	32.05	58.89	56.00	57.44	0.37	0.35	0.36
M <sub>7</sub>	36.20	32.83	34.52	64.74	61.48	63.11	0.36	0.35	0.35
M <sub>8</sub>	27.26	23.98	25.62	46.18	44.52	45.35	0.38	0.35	0.36
M <sub>9</sub>	29.32	25.79	27.56	51.10	48.32	49.71	0.36	0.35	0.35
S.Em±	2.20	1.88	1.86	3.96	2.64	2.94	0.02	0.02	0.02
CD (P=0.05)	6.64	5.69	5.62	11.97	7.99	8.89	NS	NS	NS
<b>Sub plots (N)</b>									
N <sub>1</sub>	32.64	29.07	30.86	56.48	54.01	55.25	0.37	0.35	0.36
N <sub>2</sub>	33.59	30.11	31.85	60.41	57.70	59.06	0.35	0.34	0.35
N <sub>3</sub>	34.67	31.13	32.90	61.68	58.53	60.11	0.36	0.35	0.35
S.Em±	1.56	1.55	1.37	1.76	1.71	1.26	0.01	0.01	0.01
CD (P=0.05)	NS	NS	NS	NS	NS	3.63	NS	NS	NS
Interaction (M x N)	NS	NS	NS	NS	NS	NS	NS	NS	NS

### Economics of green and brown manuring in maize – wheat cropping system

Green manuring of sunnhemp grown with maize in 1:2 ratio (Rs.1,30,618 ha<sup>-1</sup>) followed by brown manuring of sunnhemp grown with maize in 1:2 ratio (Rs. 1,27,062 ha<sup>-1</sup>) and green manuring of sunnhemp grown with maize in 1:1 ratio (Rs. 1,25,513 ha<sup>-1</sup>) recorded significantly higher gross returns compared to rest of the treatments. The lowest gross return (Rs. 85,273 ha<sup>-1</sup>) was in sole maize (60 cm x 20 cm) - wheat sequence. The net returns also differed significantly among the green and brown manuring practices under maize – wheat cropping system. Green manuring of sunnhemp grown with maize in 1:2 ratio (Rs.89,476 ha<sup>-1</sup>) followed by brown manuring of sunnhemp grown with maize in 1:2 ratio

(Rs.85,820 ha<sup>-1</sup>) and green manuring of sunnhemp grown with maize in 1:1 ratio (Rs.84,575 ha<sup>-1</sup>) recorded significantly higher net returns over other legumes used for green and brown manuring purpose. The B:C ratio was also higher with green manuring of sunnhemp grown with maize in 1:2 ratio (2.18) followed by brown manuring of sunnhemp grown with maize in 1:2 ratio (2.08) and green manuring of sunnhemp grown with maize in 1:1 ratio (2.07). Jat *et al.* (2010) [5] also reported higher net returns and B:C with green manuring. The different nitrogen levels did not differ with respect to the economics. The interaction effect due to manuring treatments as well as varying levels of nitrogen did not differ significantly.

**Table 3:** Economics of maize - wheat cropping system as influenced by different green and brown manuring practices and nitrogen levels

Treatment	Cost of cultivation of maize – wheat system (Rs. ha <sup>-1</sup> )			Gross return (Rs. ha <sup>-1</sup> )			Net return (Rs. ha <sup>-1</sup> )			B : C ratio		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
<b>Main plots (M)</b>												
M <sub>1</sub> – Maize alone (60 cm x 20 cm)	39238	39838	39538	101375	69172	85273	62137	29334	45735	1.58	0.74	1.16
M <sub>2</sub> - Maize + Sunnhemp as GM (1:1)	40638	41238	40938	133532	117495	125513	92894	76257	84575	2.29	1.85	2.07
M <sub>3</sub> - Maize + Sunnhemp as GM (1:2)	40842	41442	41142	137177	124059	130618	96335	82617	89476	2.36	1.99	2.18
M <sub>4</sub> - Maize + Sunnhemp as BM (1:1)	40738	41338	41038	131335	113902	122619	90597	72564	81581	2.22	1.76	1.99
M <sub>5</sub> - Maize + Sunnhemp as BM (1:2)	40942	41542	41242	135015	119108	127062	94073	77566	85820	2.30	1.87	2.08
M <sub>6</sub> - Maize + Cowpea as BM (1:1)	40938	41538	41238	124897	102770	113833	83959	61232	72595	2.05	1.47	1.76
M <sub>7</sub> - Maize + Cowpea as BM (1:2)	41210	41810	41510	128267	109192	118729	87057	67382	77219	2.11	1.61	1.86
M <sub>8</sub> - Maize + Dhaincha as BM (1:1)	40888	41488	41188	113207	90595	101901	72319	49107	60713	1.77	1.18	1.48
M <sub>9</sub> - Maize + Dhaincha as BM (1:2)	41143	41743	41443	117160	93914	105537	76017	52171	64094	1.85	1.25	1.55
S.Em±	-	-	-	6072	4561	3976	6072	4561	3976	0.15	0.11	0.10
CD (P=0.05)	-	-	-	18362	13793	12023	18362	13793	12023	0.45	0.33	0.29
<b>Sub plots (N)</b>												
N <sub>1</sub> - 75 % RDN	40410	41010	40710	123143	102957	113050	82734	61947	72340	2.04	1.51	1.78
N <sub>2</sub> - 100 % RDN	40731	41331	41031	124596	104478	114537	83866	63147	73506	2.06	1.52	1.79
N <sub>3</sub> - 125 % RDN	41052	41652	41352	126248	105967	116107	85196	64315	74756	2.07	1.54	1.81
S.Em±	-	-	-	2383	2277	2057	2383	2277	2057	0.06	0.05	0.05
CD (P=0.05)	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (M x N)	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS

### Conclusion

Sunnhemp as green manuring in 1:2 row proportion followed by sunnhemp as brown manuring 1:2 row proportions recorded significantly higher grain and stover yield of maize. And also influenced on succeeding wheat crop to produce higher grain and straw yield of wheat. These treatments were known to be get higher gross returns (Rs. 1,30,618 ha<sup>-1</sup> and Rs. 1,27,062 ha<sup>-1</sup> respectively), net returns (Rs. 89,476 and Rs 85,820 ha<sup>-1</sup> respectively) and B:C (2.18 and 2.08 respectively) compare to other treatments. Thus, sunnhemp as green manuring in 1:2 row proportion followed by sunnhemp as brown manuring 1:2 row proportions were proved to be very effective to increase the productivity of maize – wheat cropping system under UKP command.

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