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Response of Different Value Added Briquettes with Reference to Yield Attributes and Nutrient Status of Cashew in Konkan Region of Maharashtra

R. C. GAJBHIYE*, V. G. SALVI, S. P. SALVI and S. N. PAWAR

Cattle Breeding Farm, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,
Nileli - 416 519, Sindhudurg, Maharashtra

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The present investigation was conducted at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Cattle Breeding Farm, Nileli- 416 519, Tal. Kudal, Dist. Sindhudurg during the year 2015-2016 with a view to study the effect of different value added briquettes on flowering, fruiting, yield and nutrient status of cashew cv. Vengurla-4. The experiment was conducted in Randomized Block Design with three replications and seven treatments. The recommended package of practices was uniformly followed for all the treatments including control. The different value added briquettes were prepared at Regional Fruit Research Station, Vengurle and applied by ring method in June, 2015. The observations regarding flowering, fruiting and yield attributes were recorded at appropriate stages and the data were statistically analyzed. Among the different value added briquettes studied, soil application of Konkan Annapurna Briquettes (KAB) @ 75% + Zn + Cu + B + Mo @ 25% (T_7) recorded the maximum flowering duration (100.75 days), flowering panicles m^{-2} (23.6) and sex ratio (0.23), number of nuts per panicle (3.4), yield (15.69 kg $tree^{-1}$ and 3.94 t ha^{-1}) and apple TSS (17.8°B) and further it increased yield by 37.66% over the conventional method of application of RDF through straight fertilizers (T_1). However, the maximum fruit set m^{-2} (22.9), apple weight (94.9 g) and nut weight (8.4 g) was recorded by application of KAB @ 75% + Mo @ 25% (T_6) . Application of KAB @ 75% + Mo @ 25% (T_6) recorded maximum available N (495.49 kg ha^{-1}) while, available P_2O_5 content was found maximum in T_1 treatment (17.06 kg ha^{-1}). Whereas, available K_2O recorded significantly maximum content in T_7 treatment i.e. KAB @ 75%) + Zn + Cu + B + Mo @ 25% (410.16 kg ha^{-1}) and superior over rest of the treatments. Application of nutrients through briquettes instead of straight fertilizers appeared as a better option for cashew yield enhancement maintaining sufficient amount of nutrients in soil. However, further detail investigation in this direction in cashew is necessary.

*(**Key words:** Cashew, Konkan Annapurna briquettes, Flowering panicles, Fruit set and sex ratio)*

Cashew (*Anacardium occidentale* L.) is one of the major revenue earning crops of India contributing 6570.93 crore during the year 2014-15 (Anon., 2016). The present area under cashew in India is about 10.27 lakh ha with production of 7.33 lakh MT and productivity is 821 kg ha^{-1} (Anon., 2015). Maharashtra ranks first in area, production and productivity of cashew in the country. The area under cashew in Maharashtra is about 1.86 lakh ha with production of 2.45 lakh MT and productivity is 1267 kg ha^{-1} (Anon., 2015). The high cashew productivity in Maharashtra is mainly due to largest area under cashew being covered by high yielding export grade cashew varieties like Vengurla-4 and Vengurla-7 after the year 1990. In Konkan region of Maharashtra, cashew is mainly grown on hill slopes particularly on eroded soil. Mostly the soils which are not suitable for other crop are selected for cashew cultivation. Moreover, due to heavy rainfall during June to September, loss of applied nutrients due to leaching directly affects the overall crop growth, yield and quality of the produce. Under this situation, Konkan Annapurna briquettes fortified with micro nutrients may play the vital role in enhancing the growth, yield and quality of cashew by preventing the heavy nutrients losses through leaching and runoff. With this view, the present investigation was carried out to study the effect of different value added briquettes on growth, yield and quality of cashew and soil properties under South Konkan conditions of Maharashtra.

MATERIALS AND METHODS

The experiment was conducted during 2015-16 at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Cattle Breeding Farm, Nileli, Tal. Kudal, Dist. Sindhudurg (MS) with cashew variety Vengurla-4. Uniform 10 years old trees of cashew planted at 7 m x 7 m were selected for experimentation. The experiment was laid out in

**Corresponding Author :* E-mail: cashewresveng@gmail.com

Randomized Block Design with seven treatments and four replications. The details of treatments are as T_1: RDF (40 kg FYM, 1000:250:250 g N:P:K tree^{-1} year^{-1}), T_2: Konkan Annapurna Briquettes (KAB) - 100%, T_3: KAB (75%) + Zn (25%), T_4: KAB (75%) + Cu (25%), T_5: KAB (75%) + B (25%), T_6: KAB (75%) + Mo (25%) and T_7: KAB (75%) + Zn + Cu + B + Mo (25%). The composition of KAB is fixed *i.e.* 34% N, 14% P and 6% K.

All the briquettes were prepared as per treatment one day prior to actual application with the help of briquette machine installed at Mango Farm, Regional Fruit Research Station, Vengurle. All the treatments were applied by ring method once in the month of June, 2015. The uniform packages of practices were simultaneously followed including plant protection. The initial soil samples of the experimental plot were collected from the 0-15 cm depth and presented in Table 1. The treatment-wise soil samples of an experimental plot were collected after harvest of the crop. The collected soil samples were air-dried, ground and analyzed by adopting standard method as mentioned for pH and electrical conductivity in 1:2.5 soil: water suspension by Jackson (1973), organic carbon by Walkley and Black (1934) method, available N by alkaline permanganate method (Subbiah and Asija, 1956), available P (Bray and Kurtz, 1945) and available K by extraction with 1N ammonium acetate (NH_4OAC) solution at pH 7.0 (Jackson, 1973). All the observations regarding flowering, fruiting and yield attributes were recorded at appropriate stages. Similarly, the data recorded at different crop growth stages during investigation period was statistically analyzed as per procedure given by Panse and Sukhatme (1995).

RESULTS AND DISCUSSIONS

Initial soil characteristics

Data presented in Table 1 indicated that the soil of the experimental site was clay loam in texture, moderately acidic (pH 5.10) in reaction and electrical conductivity (0.08 dSm^{-1}) within safe limit of for plant growth. Soil was high in organic carbon content, moderately high in available nitrogen content (423.87 kg ha^{-1}) and medium in available phosphorus content (14.45 kg ha^{-1}). It showed high content of available potassium (295.10 kg ha^{-1}). As far as the micronutrients in soil were concerned, it indicated sufficient range of available iron (86.67 ppm), manganese (10.67 ppm), copper (3.78 ppm) and zinc (1.22 ppm) content. Similar findings in respect of initial soil properties of lateritic soil were also reported by Shinde *et al*. (2010).

Table 1: *Initial soil properties of the experimental site*

Sr. No.	Properties	Content
1	pH (1:2.5)	5.10
2	EC (1:2.5) (dSm^{-1})	0.08
3	Organic Carbon (%)	2.18
4	Available N (kg ha^{-1})	423.87
5	Available P (kg ha^{-1})	14.45
6	Available K (kg ha^{-1})	295.10
7	Zn (ppm)	1.22
8	Cu (ppm)	3.78
9	Fe (ppm)	86.67
10	Mn (ppm)	10.67
11	B (ppm)	0.87
12	Mo (ppm)	0.02

Effect of different value added briquettes on flowering and fruiting of cashew cv. Vengurla-4

The various treatments of value added briquettes significantly influenced the flowering and fruiting parameters of cashew. However, no significant variation was observed among the various treatments with respect to production of number of laterals m^{-2} (Table 2).

Significantly maximum flowering duration (100.75 days) was observed with combined application of KAB 75% + Zn + Cu + B + Mo @ 25% (T_7) and it was at par with T_1 and T_2 (97.25 days), respectively.

Production of panicles per m^2 of cashew were recorded significantly maximum (23.6 m^{-2}) with application of KAB @ 75% + Zn + Cu + B + Mo @ 25% (T_7) at Nileli location and it was significantly superior over rest of the treatments. Similarly, the sex ratio of cashew cv. Vengurla-4 was observed significantly maximum (0.23) with application of KAB @ 75% + Zn + Cu + B + Mo @ 25% (T_7) and was at par with treatment T_5 consisting KAB @ 75% + B @ 25% (0.21).

Combined application of KAB @ 75% + Mo @ 25% (T_6) recorded significantly maximum fruit set (22.9 m^{-2}) and at par with T_5 (22.1 m^{-2}) and T_2 (21.4 m^{-2}). Number of nuts per panicle were noted significantly maximum (3.4 nuts panicle^{-1}) by combined application of KAB 75% + Zn + Cu + B + Mo 25% (T_7) in cashew cv. Vengurle-4 and it was at par with treatment T_6 treatment consisting KAB (75%) + Mo (25%) and T_2 i.e. KAB @ 100% (3.2 nuts panicle^{-1}).

Effect of different value added briquettes on yield attributes and yield of Cashew cv. Vengurla-4

The data presented in Table 3 revealed that the effect of various value added briquettes significantly influenced the yield parameters of cashew cv. V-4. However, it showed non-significant results in respect of shelling percentage.

Application of KAB @ 75% + Mo @ 25% (T_6) recorded significantly maximum nut weight of cashew cv. Vengurla- 4 (8.4 g) followed by treatment T_7 (8.1 g). Both the treatments were at par with each other. The apple weight of cashew cv. Vengurla-4 was observed significantly maximum (94.9 g) with combined application of KAB @ 75% + Mo @ 25% (T_6) and it was superior over the rest of the treatments. However, the sweetness of cashew apple in the form of TSS (^oB) was observed significantly maximum (17.8^oB) with T_7 and at par with T_2 treatment consisting KAB @ 100% (16.5^oB).

So far as yield (kg tree^{-1}) of cashew cv. Vengurla-4 is concerned, significantly the maximum yield (15.69 kg tree^{-1}) was recorded with application of KAB @ 75% + Zn + Cu + B + Mo @ 25% (T_7) and it was at par with T_6 (15.57 kg tree^{-1}) and T_2 (13.06 kg tree^{-1}). Similarly, significantly the maximum yield of 3.94 t ha^{-1} was also recorded in Vengurla-4 with application of KAB @ 75% + Zn + Cu + B + Mo @ 25% (T_7) and it was significantly superior over rest of the treatments. No significant difference was observed among the different treatments with respect to shelling percentage. In present study, application of KAB @ 75% + Zn + Cu + B + Mo @ 25% (T_7) increased yield of 37.66% over conventional method of application of RDF through straight fertilizers (T_1).

In the present investigation, application of Konkan Annapurna Briquettes (KAB) 75% + Zn + Cu + B + Mo @ 25% (T_7) appeared as best treatment with respect to flowering, fruiting and yield followed by KAB @ 75% +

Table 2. *Effect of value added briquettes on flowering and fruiting attributes of cashew cv. Vengurla-4*

Treatment	Flowering duration (days)	No. of laterals m^{-2}	Flowering panicles m^{-2}	Sex ratio	Fruit set m^{-2}	No. of nuts panicle^{-1}
T_1: RDF (40 kg FYM;1000:250:250 g N:P:K tree^{-1}year^{-1})	97.25	25.3	19.6	0.19	18.9	2.9
T_2: Konkan Annapurna Briquettes (KAB)- 100%	97.25	26.5	21.3	0.19	21.4	3.2
T_3: KAB (75%) + Zn (25%)	93.50	25.5	19.3	0.19	18.9	2.8
T_4: KAB (75%) + Cu (25%)	92.00	26.5	21.4	0.20	18.4	2.4
T_5: KAB (75%) + B (25%)	91.75	24.3	17.5	0.21	22.1	2.8
T_6: KAB (75%) + Mo (25%)	93.25	26.3	21.3	0.19	22.9	3.3
T_7: KAB (75%) + Zn + Cu + B + Mo (25%)	100.75	27.0	23.6	0.23	18.8	3.4
SEm ±	1.35	0.88	0.71	0.006	0.55	1.14
CD @ 5%	4.00	N.S	2.01	0.017	1.64	0.43

Table 3. *Effect of value added briquettes on yield and quality of cashew cv. Vengurla-4*

Treatment	Apple wt. (g)	Nut wt. (g)	Yield (kg tree^{-1})	Yield (t ha^{-1})	Shelling (%)	Apple TSS (^0B)
T_1: RDF (40 kg FYM;1000:250:250 g N:P:K tree^{-1} year^{-1})	63.8	6.8	9.78	1.96	29.8	13.2
T_2: Konkan Annapurna Briquettes (KAB)- 100%	65.5	7.3	13.06	2.84	29.6	16.5
T_3: KAB (75%) + Zn (25%)	85.0	7.5	9.98	1.90	29.6	15.3
T_4: KAB (75%) + Cu (25%)	53.0	7.2	10.36	2.25	29.2	14.8
T_5: KAB (75%) + B (25%)	63.1	7.6	11.16	1.88	29.6	15.7
T_6: KAB (75%) + Mo (25%)	94.9	8.4	15.57	3.06	30.0	15.6
T_7: KAB (75%) + Zn + Cu + B + Mo (25%)	61.9	8.1	15.69	3.94	30.8	17.8
SEm ±	1.45	0.22	1.09	0.22	0.40	0.47
CD @ 5%	4.32	0.65	3.25	0.65	N.S	1.40

Table 4. *Effect of value added briquettes on soil properties after harvest at Nileli location (2015-16)*

Treatment	pH	EC dSm^{-1}	OC (%)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
T_1: RDF (40 kg FYM; 1000:250:250 g N:P:K $tree^{-1}$ $year^{-1}$)	5.47	0.05	2.85	445.00	17.06	381.70
T_2: Konkan Annapurna Briquettes (KAB)- 100%	5.59	0.06	2.61	457.62	16.53	353.93
T_3: KAB (75%) + Zn (25%)	5.63	0.11	2.85	492.34	14.91	313.95
T_4: KAB (75%) + Cu (25%)	4.96	0.10	1.99	441.84	16.18	361.65
T_5: KAB (75%) + B (25%)	5.72	0.10	2.13	470.24	15.50	378.32
T_6: KAB (75%) + Mo (25%)	5.12	0.10	1.91	495.49	16.63	300.00
T_7: KAB (75%) + Zn + Cu + B + Mo (25%)	4.82	0.07	2.38	459.46	16.04	410.16
SEm ±	-	-	-	3.66	0.26	2.50
CD @ 5%	-	-	-	10.88	0.78	7.43

Mo @ 25% (T_6) and KAB @100% (T_2). The application of KAB either alone or in combination with micro-nutrients (Zn, Cu, B and Mo) in the form of briquettes helped slow and constant release of all the required essential primary NPK nutrients and other micro-nutrients which later on become readily available to the cashew plants. This resulted in further enhancement in plant growth and development in terms of yield without much loss of nutrients through leaching, runoff and percolation. While, low yield was obtained in T_1 treatment due to application of RDF through the convectional method in the form of straight fertilizers that might have resulted into more losses of nutrients through leaching and further the low availability of major NPK nutrients to the plant. Present findings are in line with Choudhury *et al.* (2015) who showed that soil application of NPK briquettes gave higher vegetable yields (28.8% for cucumber, 25.6% for taro and 10.8% for bitter gourd). Kokare *et al*. (2015) reported that application of Urea-Godavari briquettes (3 briquettes per plant) was found significantly superior over rest of all the treatments in respect of chilli yield. Darade and Banker (2009) reported that application of urea-DAP briquettes @114 kg N + 25.4 kg P + 50 kg K_2O ha^{-1} along with $ZnSO_4$ @ 25 kg ha^{-1} recorded significantly higher grain yield as compared to all other treatment combinations. Patil *et al*. (2015) reported that the higher yield attributing characters resulted into significant increase in grain yield (25.20 q ha^{-1}) and straw yield (32.72 q ha^{-1}) with application of RDF through briquettes. Naznin *et al*. (2013) reported that application of USG and NPK briquette may be practiced for obtaining better rice yields in addition to increasing the efficiency of N fertilizer. Akhtar *et al.* (2015) observed that USG and NPK briquette produced 9.78 and 23.7% higher yield of bottle gourd over prilled urea. Grain yield was significantly increased when the rice crop was fertilized with NPK briquettes (Mendhe *et al.,* 2006; Bulbule *et al.,* 2008) which are in confirmity with the present findings.

Effect of different value added briquettes on available nutrient status of soil after harvest

The different properties of soil i.e. pH, EC and organic carbon content and available soil N, P_2O_5 and K_2O content after crop harvest was analyzed and presented in Table 4. The soil of experimental plot was lateritic and moderately acidic in reaction. The pH of soil ranged from 4.82 to 5.72 and electrical conductivity ranged from 0.05 to 0.11 dSm^{-1} and was within safe limit for plant growth. While, soil organic carbon content ranged from 1.91 to 2.85% and showed high content of organic carbon in soils. Application of various value added briquettes significantly influenced the available soil N, P_2O_5 and K_2O after crop harvest as compared to initial soil status. Application of KAB @ 75% + Mo @ 25% (T_6) recorded significantly maximum available N (495.49 kg ha^{-1}) and it was at par with treatment T_3 consisting KAB @ 75% + Zn @ 25% (492.34 kg ha^{-1}) while, available P_2O_5 content was found significantly maximum in T_1 treatment (17.06 kg ha^{-1}) and at par with T_6 (16.63 kg ha^{-1}) and T_2 (16.53 kg ha^{-1}). Whereas, available K_2O content was recorded significantly maximum in T_7 treatment *i.e.* KAB @ 75%) + Zn + Cu + B + Mo @ 25% (410.16 kg ha^{-1}) and was superior over rest of the treatments.

CONCLUSIONS

Among the different value added briquettes tested, application of Konkan Annapurna Briquettes (KAB)

@ 75% + Zn + Cu + B + Mo @ 25% increased the cashew yield by 36.39% over conventional method of application of RDF through straight fertilizers and it appeared as better option for cashew yield enhancement maintaining sufficient amount of nutrients in soil after harvest of cashew. However, further detail investigation in this direction in cashew is necessary.

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