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Impact of Floor Management using Banana Biomat Mulch and Leguminous Cover crop on Available Nitrogen in Soil, Growth, Yield and Quality of Banana cv. Martaman

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Abstract: The present investigation was carried out at ICAR-AICRP on Fruits, Mohanpur, Bidhan Chandra Krishi Vishwavidyalaya, Mondouri, Nadia, West Bengal with six treatments. Banana Biomat Mulch (BBM) @ 30 kg fresh/m^{-2} + Leguminous Cover Crops (LCC) @ 3g seeds/ m^{-2} + 0% recommended dose of fertilizer or 25, 50%, 75% and 100 % RDF practices (no BBM & LCC with 100% RDF i.e., 5kg FYM, N-200g + P_2O_5-50g + K_2O-250g/plant/year. Treatments were imposed thrice a year on orchard floor of banana cv. Martaman. Observations were recorded on plant height, girth, leaf number per plant, status of nitrogen content, qualitative and quantitative parameters such as bunch weight, finger weight, finger length, finger diameter, number of fingers per bunch, hands per bunch, total sugar, acidity, sugar: acid ratio and productivity. The application of BBM+LCC with 75 or 100% of RDF significantly increased plant height, girth and number of leaves per plant two months after third treatment. The increase in average available nitrogen content in soil, bunch weight, number of hands per bunch, finger per bunch, finger weight, finger length, finger diameter, total sugar, acidity, sugar: acid ratio and productivity was higher as compared with conventional practice and BBM + LCC and RDF @ 0-50%.

Keywords: Banana, Mulching, Soil, Nitrogen, Yield and quality

Banana (*Musa paradisiaca*) is diploid, triploid and tetraploid (n=11) and belongs to the family Musaceae. It is one of the most important, common and favorite fruit, originated from South East Asia (Indo Malayan). Banana is 4th important food crop in terms of gross value. It is a very popular fruit due to its high nutritive value with low price. It is very predominant and popular among people that it is liked by both poor and rich. It can be consumed as ripe as well as cooked. In banana, fruit size and quality are of great importance through consumer acceptance varies from place to place (Bauri et al 2014). India has a production of 31504 metric tonnes from the area of 878 thousand hectares. The productivity of banana in India is 37 metric tonnes per hectare (Anonymous 2019).

In commercial banana cultivation, out of the total biomass produced by a banana plant (cv. Martaman), only 15-20 % constitute the fruits and marketed immediately but rest biomass (80-85%) including pseudo stem, leaf, rhizome etc. is a neglected waste and not used properly. The unutilized biomass was estimated to be about 150 tonnes/ha (Debnath et al 2010). Utilization of banana crop waste is a cheap source of nutrients and increases organic matter, stimulate soil microbial life enhances water holding capacity and increases crop yields (Phirke and Kothari 2005). Mulching is a process of covering the soil and make more favorable conditions for plant growth and development. It is an important cultural method of reducing the amount of work involved in gardening and helps to produce healthy plants with good productivity (Sathiyamurthy et al 2017). It is a practice which helps in proper growth and development of the plants by providing better soil moisture conservation and better nutrient availability (Kher et al 2010). Application of organic mulching such as dry grass in banana significantly increased plant height, stem girth, number of leaves, length and girth of fruit, fruit weight and bunch weight (Wankhade et al 2023). Organic mulching helps to regulate soil temperature, water use efficiency, plant growth, quality and yield (Amare and Desta 2021). Organic mulching and leguminous cover crops have a beneficial effect on vegetative growth, nutrient content, quality and quantity of banana (Subba et al 2023). Plant height as well as other vegetative growth can be significantly increased due to sufficient soil moisture near root zone and minimum evaporation loss due to organic mulching (Marichamy et al 2016). Organic mulches derived from plants such as straw, hay, husk, saw dust and leaves improve soil physical properties, supply organic matter, improve nitrogen balance resulting in increasing yield and productivity (Sarolia and

Bhardwaj 2013). Cover crops have long been used to reduce soil erosion and water runoff, and improve water infiltration, soil moisture conservation, and also helps in improving soil tilth, organic carbon and nitrogen (Sainju and Singh 1997). Based on the above background, the present studies were conducted.

MATERIAL AND METHODS

The investigation was carried out at Bidhan Chandra Krishi Vishwavidyalaya, Mondouri, Nadia, West Bengal, during the year 2018-2020. Healthy and uniform sword suckers of banana cv. Martaman (500-750 g) were collected and planted at 2 m x 2 m spacing as per the layout of experimental design in randomized block design with 4 replications and 10 plants per replication (Table 1). The recommended dose of fertilizer (RDF) used in the experiment of banana was 5kg FYM, N-200g + P_2O_5-50g + K_2O-250g/plant/year. Application rate was between 0 and 100% of RDF based on treatments. The treatments consisted of application of banana biomat mulch (BBM), leguminous cover crop (LCC) and different level of fertilizer doses. The overnight soaked seed of leguminous cover crop (LCC) was sown @ 3g m^{-2} in the ground area of plants as per the treatment, about 36-48 hours after irrigation. Black gram var. Kalindi was sown during winter and spring months and moong bean var. Samrat was sown during summer and rainy months. The pseudo stem of banana was collected from the harvested banana field. Strips were prepared by cutting the leaf sheath of pseudo stem into 1.4-1.5 m in length and 10-15 cm in wide. The banana biomat mulch (BBM) was prepared by weaving the strips cross-wise and were spread on the ground area of each plant @ 30 kg fresh m^{-2}. Pre-soaked moong bean seeds along with vermicompost was sown at 25-30 cm spacing in between the two banana strips of BBM. The grown up LCC was incorporated in soil during 50 to 60 days after sowing.

Table 1. Treatment details

Treatments	Combination
T_1	BBM @ 30 kg fresh m^{-2} + LCC @ 3g seeds m^{-2} + 0% RDF
T_2	BBM @ 30 kg fresh m^{-2} + LCC @ 3g seeds m^{-2} + 25% RDF
T_3	BBM @ 30 kg fresh m^{-2} + LCC @ 3g seeds m^{-2} + 50% RDF
T_4	BBM @ 30 kg fresh m^{-2} + LCC @ 3g seeds m^{-2} + 75% RDF
T_5	BBM @ 30 kg fresh m^{-2} + LCC @ 3g seeds m^{-2} + 100% RDF
T_6	Control – No BBM & LCC with 100% RDF

*BBM-banana biomat mulch, LCC-leguminous cover crops, RDF-recommended dose of fertilizer i.e., 5kg FYM, N-200g + P_2O_5-50g + K_2O-250g/plant/year

Application of treatments was repeated three times: First application at the time of planting (10-25 August, 2018), second application at 3 months after 1st application (10-25 November, 2018, at plant age of 3 months) and third application at 6 months after 1st application (10-25 February, 2019, at plant age of 6 months). Observations were recorded on plant height, plant girth, number of leaves per plant, nitrogen content, bunch weight, number of hands per bunch, total sugar, acidity, sugar: acid ratio, productivity, number of finger per bunch, finger length, finger weight and finger width. The data was analysed in Statistical Package for the Social Sciences software.

RESULTS AND DISCUSSION

Plant height, girth and leaf number two month after 1st treatment: All treatments with banana biomat mulch (BBM) and leguminous cover crop (LCC) with varying dose of fertilizer on banana cv. Martaman caused non-significant variations in plant height, plant girth and number of leaves per plant (Table 2). The minimum plant height (58.75 cm) was in T_1 i.e., mulching with BBM & LCC + 0% RDF and maximum) (79.23 cm) plant height was recorded under in mulching with BBM & LCC + 100% RDF. The minimum plant girth (20.99 cm) was in T1 and maximum (25.00 cm) was under T_3 treatment i.e., mulching with BBM & LCC + 50% RDF. The minimum number of leaves per plant (4.00) were in T_1 & T_6 treatment and maximum (5.75) in T_5 treatment i.e., mulching with BBM & LCC + 100% RDF.

Plant height, girth and leaf number two month after 2nd treatment: The significant increase in plant height, girth and number of leaves per plant was recorded during the period of 2nd treatments on banana cv. Martaman (Table 2). The minimum plant height (83.42 cm) was in mulching with T_1 treatment (BBM & LCC + 0% RDF) and maximum (107.49 cm) plant height was recorded under T_5 i.e., mulching with BBM & LCC + 100% RDF. The minimum (32.93 cm) plant girth was in T_1 and maximum (52.33 cm) was under T_5. The minimum (9.00) number of leaves per plant (9.00) were in T_6 treatment and maximum (12.00) leaf number per plant (12.00) was recorded under T_5 Francois et al (2020) and Kumar et al (2020) also reported that organic mulching can significantly increase plant height, girth and number of leaves in banana. Subba et al (2023) also reported the beneficial effect of using organic mulching to increase the vegetative growth of banana. Similar effect of organic mulching on plant growth, plant girth and leaf number per plant were reported earlier in guava by Patra et al (2004).

Plant height, girth and leaf number two month after 3rd treatment: All treatments with banana biomat mulching (BBM) and leguminous cover crop (LCC) with varying dose of

fertilizer on banana cv. Martaman caused significant variations in plant height, plant girth and number of leaves per plant (Table 2). The minimum plant height (149.32 cm) was in recorded under T_1 treatment i.e., mulching with BBM & LCC + 0% RDF and maximum (180.03 cm) was under T_5 treatment i.e., mulching with BBM & LCC + 100% RDF. The minimum plant girth (45.63 cm) was in T1 maximum plant girth (63.80 cm) was under T5. The minimum leaf number per plant (11.25) was T_1 and T_6 and maximum number of leaves per plant (14.00) was recorded under T_5 Wankhede et al (2013) and Francois et al (2020) also reported that organic mulching can significantly increase plant height, girth and number of leaves in banana. This observation was in agreement with the observation of Subba et al (2023) where vegetative growth increased by using organic mulching with leguminous cover crops. Similar finding of using organic mulching on plant growth, plant girth and leaf number per plant were reported earlier in guava by Maji and Das (2008) and Bhattacharjee et al (2020).

Available nitrogen (Kg ha^{-1}): All treatments with banana biomat mulch (BBM) and Leguminous cover crop (LCC) with varying dose of fertilizer on banana cv. Martaman caused significant variations in available nitrogen content in soil except the initial month of experiment (Aug,18) (Table 3). The minimum (164.88 Kg ha^{-1}) available nitrogen was in T_1 and maximum (171.66 Kg ha^{-1}) in T_5. However, the effect of T_2 and T_6 were statistically at par. Kher et al (2010) and Subba et al (2023) also reported the same trend. Sarolia and Bhardwaj (2013) observed organic mulching and cover crops can increase the organic matter and nitrogen content in soil. Frame (2005) and Peoples et al (2009) reported similar effect of legume crops grown as cover crops and those incorporated in orchard soil between 50-60 days after sowing and hence, it was considered to add 30-40 kg nitrogen per hectare.

Yield and quality of banana: Mulching with different treatments showed significant increase in bunch weight, number of hands per bunch, total sugar, acidity, sugar: acid ratio and productivity (Table 3). The maximum bunch weight (19.43 kg) was in T_5 and minimum bunch weight (14.01 kg) was obtained from T_1. The maximum number of hands per bunch (8.54) was in T_5 and minimum (7.08) was in T_6 treatment. The maximum total sugar (12.82%) was in T_5 and minimum (8.55%) in T6. The maximum acidity (0.29%) was recorded under T_4 treatment and minimum (0.26%) in T_1 and T_6. The sugar: acid ratio was recorded highest (47.48) in T_5

Table 2. Effect of banana biomat mulch and leguminous cover crop on vegetative growth of banana plant (2 month after treatment)

Treatments	1st treatment			2nd treatment			3rd treatment		
	Plant height (cm)	Girth (cm)	Leaf no. per plant	Plant height (cm)	Girth (cm)	Leaf no. per plant	Plant height (cm)	Girth (cm)	Leaf no. per plant
T_1	58.75	20.99	4.00	83.42	32.93	9.25	149.32	45.63	11.25
T_2	66.88	20.38	5.25	89.65	40.70	9.75	158.21	53.84	12.00
T_3	72.75	25.00	4.25	94.90	45.66	10.50	166.71	56.22	12.75
T_4	76.75	24.38	4.50	98.82	48.18	11.25	175.05	60.00	13.25
T_5	79.23	24.13	5.75	107.49	52.33	12.00	180.03	63.80	14.00
T_6	62.86	21.88	4.00	87.70	36.04	9.00	155.18	48.24	11.25
CD (p=0.05)		NS		5.23	4.68	1.79	1.53	6.49	0.99

During October, 2018 (2 months after 1st treatment in August, 2018), January, 2019 (2 months after 2nd treatment in November, 2018) and during April, 2019 (2 months after 3rd treatment in February, 2019)

Table 3. Effect of banana biomat mulch and leguminous cover crop on available nitrogen content (kg ha^{-1}) of soil in banana orchard

Treatment	Initial (August, 18)	November, 2018	February, 2019	May, 2019	Average
T_1	159.23	165.75	166.47	168.09	164.88
T_2	159.82	167.61	169.31	170.18	166.73
T_3	159.48	170.4	171.41	172.03	168.33
T_4	159.08	172.57	173.74	174.31	169.92
T_5	159.37	174.16	176.02	177.09	171.66
T_6	159.33	166.61	168.52	169.91	166.01
CD (p=0.05)		5.92	5.28	1.841	-

Table 4. Effect of banana biomat mulch and leguminous cover crop on fruit yield and quality of banana cultivation

Treatments	Bunch wt. (Kg plant^{-1})	No. of hands/ bunch	Total sugar (%)	Acidity (%)	Sugar acid ratio	Productivity (t ha^{-1})
T_1	14.01	8.17	10.17	0.26	39.1	35.02
T_2	17.56	8.24	10.79	0.28	38.53	38.28
T_3	18.18	8.26	11.36	0.28	40.57	38.96
T_4	18.9	8.39	11.92	0.29	41.1	39.1
T_5	19.43	8.54	12.82	0.27	47.48	40.58
T_6	16.93	7.08	8.55	0.26	32.88	37.5
CD (p=0.05)	0.861	0.075	0.09	0.04	2.66	0.13

Table 5. Effect of banana biomat mulch and leguminous cover crop on finger characters of banana cv. Martaman

Treatments	No. of finger/bunch	Finger wt. (g)	Finger length (cm)	Finger diameter (cm)
T_1	117.50	115.79	10.95	3.95
T_2	123.50	122.58	11.25	4.14
T_3	127.69	125.40	11.17	4.12
T_4	130.91	127.70	11.35	4.18
T_5	133.48	131.99	11.45	4.27
T_6	120.62	105.56	10.14	3.36
CD (p=0.05)	4.060	2.932	0.416	0.062

lowest (32.88) in T_6 (32.88). The variations in productivity ranging from 35.02 to 40.58 t ha^{-1}. The minimum productivity (35.02 t ha^{-1}) was in T_1 and maximum (40.58 t ha^{-1}) was recorded under T_5. Similar results were in tune with the finding of Wankhede et al (2013), Francois et al (2020), Kumar et al (2020) and Subba et al (2023). The results are in accordance with Das et al (2010) and Rajput et al (2014) in guava, and Ghosh and Tarai (2007) in ber. The minimum number of fingers (117.50) was recorded under T_1 and maximum (133.48) in T5. The maximum finger weight and length was in T_5 (131.99 g, 11.45 cm) The highest finger diameter (4.27 cm) was in T_5 and lowest (3.36 cm) in T_6 treatment. However, T_2 and T_3 were statistically at par. Kumar et al (2020) and Francois et al (2020) also observed same trend.

CONCLUSION

Based on current study recommended for the banana growers in the Gangetic Alluvium region of West Bengal to apply banana biomat mulch (webbed leaf-sheath of banana @ 30 kg fresh m^{-2}), leguminous cover crops (@ 3g m^{-2}; black gram cv. Kalindi in winter, mung bean cv. Samrat in summer) thrice a year in banana (at planting time and at 3 & 6 months after planting) and 75% of recommended dose of fertilizer (in 3 splits at 3, 6 & 9 months after planting), followed by incorporation of leguminous cover crops into the soil at 50-60 days after sowing for beneficial effects on vegetative growth, available nitrogen content in soil, better fruit quality, higher fruit yield and productivity of banana cv. Martaman (AAB).

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