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EFFECT OF DIFFERENT TYPES OF MULCHES ON GROWTH AND YIELD OF TURMERIC

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Abstract

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) sub-station Khagrachari during 2020-2021 to compare the effect of different mulches on the growth and yield of Binahalud-1. Experiment was conducted with different organic mulches vizs., bamboo leaf, paddy straw, water hyacinths, and silver color plastic. A treatment without mulching was also kept as a control. The experiment was laid out in a randomized block design with three replications. The results indicated that the plants mulched with bamboo leaves recorded maximum average plant height of 150 cm, number of leaves 71.333, number of tillers 11, leaf length and leaf width 80 cm, 16.66 cm, leaf weight 29.33 gm, petiole length 40 cm and petiole weight 17.33 gm as compared to other mulches. In case of the yield of turmeric, the bamboo leaf mulch gave maximum fresh rhizome yield of 33.2 t ha^{-1}. From this study it is revealed that among the treatments bamboo leaf is the best mulch material for turmeric production.

Key words: Turmeric, Mulch, Bamboo leaf, Paddy straw, Water hyacinths, Silver color plastic, Rhizome.

Turmeric (*Curcuma longa* L.) is an annual herbaceous plant, that belongs to the order Zingiberales and family Zingiberaceae, commonly known as 'Haldi'. Turmeric powder contains 1.8-5.4% curcumin, 2.5-7.2% essential oil (turmerol), 5% fat, 3.0% minerals and 69.4% carbohydrates (Barrero and Carreno, 1999). The yellow color of turmeric is attributed to a mixture of curcuminoids and curcumin (Diferuloyl methane, $C_{12}H_{20}O_6$) (Mattes *et al*., 1980; Maheshwari *et al*., 2006).

In 2016-2017, the total area under turmeric farming was estimated to be around 62,746 acres (with production of 1, 43,542 metric tons), while in 2017-2018 it was 63,549 acres (with production of 1,49,985 metric tons), while in 2018-2019 it was 69,645 acres (with production of 1,47,439 metric tons), which indicates an average increase of area and production of turmeric in Bangladesh (BBS, 2018-2019).

Turmeric is a good source of income for the hilly people of Bangladesh. The study estimated the profitability and technical efficiency of turmeric cultivation in Khagrachhari district. In total 150 turmeric farms located in Khagrachari Sadar, Panchari, and Matiranga Upazilas of Khagrachari district, were surveyed. Data were collected, using a pre-tested questionnaire during January 2015.

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Mulching has played an important role in agricultural practices and large amounts of nitrogen fertilizer have been used to increase food production (Qin *et al.*, 2015; Tilman *et al*., 2001). There is an urgent need to reduce the environmental impacts of the rapid development of agriculture. Therefore, the effects of mulching and nitrogen fertilizers on the soil environment associated with crop plants need to be discussed.

Field mulching is an important agronomic practice that serves to protect the soil and increase crop yield (Giller *et al*., 2009; Knowler and Bradshaw *et al*., 2007). Many different materials are used as mulch, such as plastic films, wheat straw, barley straw, maize stalks, pebbles, fine sand, gravel, biological geotextiles, vegetative residues, and crushed stones (Chakraborty *et al*., 2010; Mo *et al*., 2016; Prosdocimi *et al.*, 2016a.b).

The purpose of this study was to determine how mulch materials affect the development and productivity of turmeric and to find out the best mulch treatment. The experiment was carried out in the field of BINA Sub-station Khagrachari, Bangladesh during the period from April 2020 to April 2021. Khagrachari is located at 23.0417°N 91.9944°E. The soil of the experimental area belongs to AEZ No. 29 which called northern and estern hills. The seleetcd plot was medium high land and the soil series was Tejgaon. The characteristics of the soil under the experimental plot were analyzed in the Soil Testing Laboratory, SRDI Rangamati and the soil was developed from sandstone and silt stone sedimentary rocks with fairly water holding capacity having pH from 4.5 to 5. The climate of experimental site was under the tropical climate, characterized by three distinct seasons, the monsoon or the rainy season from November to February and the pre-monsoon or hot season from March to April and the monsoon period from May to October. In this research work Binahalud-1 was collected from BINA for planting purpose with five mulches treatments were T_1= Silver colour plastic, T_2= Water hyacinths, T_3= Paddy straw, T_4= Bamboo leaf and T_5= Control (without mulching)**.** The experiment was laid out in a randomized complete block design with three replications. The treatments were randomly distributed to the unit plots in each block. Total number of plots was 15 and the unit plot size was 4m × 2.5m and block to block distance was 0.50m.

Recommended fertilizers were used, Well-rotten cow-dung, TSP (entire), MP (entire) and urea, (50% of the total amount) were applied during final land preparation. Rest of urea was applied in two equal installments at 90 DAP and 120 DAP of turmeric rhizomes/fingers. Rhizornes/fingers were planted maintaining 50 x 25 cm spacing between and within the rows. The seed rhizomea/lingers were planted at a depth of 7.5-8.0 cm on 12 May, 2020.

All Intercultural operations, plant protection measures, were done periodically whenever necessary.The crop was harvested on April, 2021 when the leaves turned yellow and started drying up. Data were collected on different yield contributing characters and yield. The plants of the outer two rows and the extreme ends of the middle rows were

excluded to avoid the border effect. Five plants were randomly selected from each plot for recording the data. Emergence was recorded at an interval of 3 days starting from the commencement of the completion of 80% emergence. The height of the tallest petiole over the ground was considered as the height of the main plant and was recorded in cm at an interval of 30 days starting from 60 days after planting. The unfurled, green and yellowish leaves were counted as leaves at an interval of 30 days starting from 60 days after planting. The number of tillers per clump was recoded at the maximum vegetative growth stage. Ten plants were selected from each plot and 3 leaves viz. large, medium and small per plant were used for measurement. Ten plants were selected from each plot and 3 leaves viz, large, medium and small per plant were used for measurement. The weight of fresh mother rhizome was measured with the help of a balance at the time of harvest and the number of primary finger rhizomes per selected clump was also recorded. The number of secondary finger rhizomes per selected clump was recorded and the weight of fresh secondary finger rhizomes was measured at the time of harvest. Finally the yield of all plants in each unit plot was recorded at the time of harvest. The data obtained for different characters were statistically analyzed to find out the significance of the difference of the effects of different mulches materials on yield and yield contributing characters of turmeric.

Different mulching practices showed significant effect on growth and yield of turmeric (Table 1 and Table 2). From Table 1, it was revealed that the bamboo leaf mulches significantly influence on plant growth and yield of turmeric in comparison to water hyacinth, paddy straw, silver color plastic sheet, and without mulch (control). In this trial, the plant height varied significantly from 132.667 to 150 cm. The plants mulched with bamboo leaves recorded the highest plant height 150 cm followed by the plants mulched with water hyacinth 145.667 cm.

Table 1. Effect of Mulching on growth parameters of turmeric (Binahalud-1)

Treatment	Plant height (cm)	No. of leaves/ plant	Leaf weight (g)	No. of tillers/ plant	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Petiole weight (g)	Days to maturity (day)
T_1	136.33d	52.33d	21.00d	6.00c	68.00d	14.00d	34.16d	13.33c	301
T_2	145.67b	63.67b	26.00b	9.33b	76.33b	16.00b	37.67b	15.67b	285
T_3	139.33c	55.33c	23.5c	8.67b	71.67c	15.17c	35.50c	14.67b	295
T_4	150.00a	71.33a	29.33a	11.00a	80.00a	16.67a	40.00a	17.33a	281
T_5	132.67e	49.33e	18.00e	5.67c	64.00e	13.17e	33.00e	12.67c	306
Mean	140.8	58.39	23.57	8.14	71.99	14.99	36.06	14.74	293.6
SE	3.14	4.02	1.96	1.02	2.42	0.63914	1.252	0.83274	-
CV%	4.98	15.40	18.59	27.89	5.80	9.528	7.65	12.638	-

T_1= Silver colour plastic, T_2= Water hyacinths, T_3= Paddy straw, T_4= Bamboo leaf and T_5= Control (without mulching)**.** Means with common letter in column sre not different significantly by LSD $_{(0.05)}$.

In the case of a number of leaves, the treatment T_4 (bamboo leaf mulch) recorded the highest number of leaves 71.333 and the lowest number of leaves 52.333 registered by the treatment T_5 (without mulch). The number of tillers per plant responded significantly to different mulching materials. The use of bamboo leaf, water hyacinth, paddy straw, and plastic mulch responded tillers per plant increased to that of control (Table 1). The highest number of tillers per plant leaf 11 was obtained in bamboo leaf as mulch that was significantly different from control as well as other treatments. The lowest number of tillers per plant leaves 5.67 was recorded in without any mulch.

The leaf length and leaf width were significantly higher in bamboo leaf mulch 80 cm, 16.66 cm respectively and followed by paddy straw mulch 71.67 cm, 15.166 cm respectively. The results obtained without any mulch (control) were 64 cm, and 13.166 cm respectively. The leaf weight was statistically significant in different treatments. The leaf weight was significantly higher in bamboo leaf mulch 29.33 gm respectively and followed by paddy straw mulch 23.25 gm respectively. The results obtained without any mulch (control) were 18 gm, respectively. The petiole length was statistically significant in different treatments. The petiole length was significantly higher in bamboo leaf mulch 40 cm respectively and followed by paddy straw mulch 35.5cm respectively. While the results obtained without any mulch (control) were 33 cm respectively. The petiole weight was statistically significant in different treatments. The petiole weight was significantly higher in bamboo leaf mulch 17.33 gm respectively and followed by paddy straw mulch 14.67 gm respectively. The results obtained without any mulch (control) were 5 gm respectively.

The days to maturity were statistically significant in different treatments. The days to maturity were significantly lowest in bamboo leaf mulch 281 days respectively and followed by paddy straw mulch 295 days respectively. The results obtained without any mulch (control) were 306 days respectively.

Similarly, results in Table 2 showed that weight of bulb with roots (kg) and weight of bulb without roots (kg) was statistically significant in different treatments. The weight of bulb with roots (kg) and weight of bulb without roots (kg) were significantly higher in bamboo leaf mulch 1.456 gm and 1.348 gm respectively and followed by paddy straw mulch 1.173 gm and 1.105 gm respectively. While the results obtained without any mulch (control) was 0.981 gm, and 0.945 gm respectively.

In Table 2 showed that the finger length and width was statistically significant in different treatments. The finger length and width were significantly higher in bamboo leaf mulch 15.11 cm and 8.7 cm respectively and followed by paddy straw mulch 10.5 cm and 7.6 cm respectively. While the results obtained the without any mulch (control) was 8.03 cm and 6.6 cm respectively. The finger weight was statistically significant in different treatments. The finger weight was significantly higher in bamboo leaf mulch 104.333 gm respectively and followed by paddy straw mulch 67.333 gm respectively. While the results obtained the without any mulch (control) was 38.333 gm respectively. Among various

treatments, the highest fresh rhizome yield 33.2 t ha^{-1} was recorded under treatment T_4, which increased by 17 per cent over control. The low yield was recorded under control i.e., without mulch 20.4 t ha^{-1}. Mulching with bamboo leaf in turmeric field have recorded significantly higher rhizome yield over mulching with paddy straw and silver color plastic sheet.

Table 2. Effect of Mulching on yield parameters of turmeric (Binahalud-1)

Treatment	Weight of bulb roots (kg)	Weight of bulb without roots (kg)	Length of finger (cm)	Diameter of finger (cm)	Weight of finger (gm)	Rhizome yield (t ha^{-1})
T_1	1.07d	0.996d	9.00cd	7.33c	44.67d	29.1b
T_2	1.20b	1.16b	11.67b	8.07b	85.00b	32.3a
T_3	1.17c	1.11c	10.50bc	7.60bc	67.33c	30.5ab
T_4	1.46a	1.35a	15.11a	8.73a	104.33a	33.2a
T_5	0.98e	0.95e	8.03d	6.60d	38.33d	20.4c
Mean	132.20	57.53	19.13	9.33	65.334	29.1
SE	5.670219	5.168965	1.108506	1.35401	1.709457	2.2880
CV%	9.59	20.08	12.95	32.44	5.85	17.58

T_1= Silver colour plastic, T_2= Water hyacinths, T_3= Paddy straw, T_4= Bamboo leaf and T_5= Control (without mulching)**.** Means with common letter in column sre not different significantly by LSD $_{(0.05)}$**.**

A good mulching material with adequate supply of nutrients is essential for plants to attain maximum production. It was observed from this experiment that mulching effectively regulates soil temperature and preserves soil water (Iqbal *et al.,* 2006). The effect of mulch on the plant height was significant and the number of leaves increased steadily over the season. The increased leaf growth under dry grass mulch was attributed to the fact that grass mulch reduces runoff following decomposition; therefore, soil structure is likely to benefit from the use of organic mulches (Feldman *et al.,* 2000).

The effect of mulch on the number of tillers was significant throughout growing period when plants under grass mulch. Grass mulch could have promoted tiller development due to the decomposed organic matter optimizing water use efficiency, and enhancing root and shoot growth. Changes in root zone temperature can affect the uptake and translocation of essential nutrients, therefore influencing root and shoot growth of crops (Chu *et al.,* 2016). The observed enhancement on tillers with types of mulches might also beat tributed to the benefits of organic mulches which lead to increased organic matter to the soil, reduced water loss, and reduced soil erosion (Chu *et al.,* 2016) leading to the promotion of vegetative growth, which positively reflects on tillers. Soil temperature can be adjusted with the use of mulches. Mulches reduce soil evaporation and increase yield through increasing water use efficiency (Adekalu *et al.,* 2006). Mulches on the soil surface reduce evaporation, increase water infiltration, control soil erosion as well as improving soil structure; thus, affecting plant growth and yield affect (Bakshi *et al.,* 2015).

The yield of turmeric was also influenced statistically under different mulching treatments. All mulching treatments influenced to increase the turmeric yield. Maximum yield of in 33.2 t ha^{-1} in bamboo leaf mulch followed by water hyacinths and paddy straw mulched. The improvement of yield might be related to the elevated soil temperature and the quality of radiation under the cover. Similar results were obtained by Wang *et al.,* (2002). Sharma *et al.,* (2008) reported that grass cover significantly improved plant physiology, growth and yield. They concluded that berry weight and yield were the highest in plants grown under grass and black plastic mulch. Ibara *et al.,* (2001) found similar results on growth of muskmelon. (Groszmann *et al.,* 1954) also reported uniform germination by mulching which corroborates with these findings. Also, mulches facilitated in better mineralization and availability of nutrients in modifying the various yields attributes to the better advantage of rhizome yield.

Turmeric growing with mulches improved all growth parameters and yield as compared to control. Among the mulching treatments biological mulches (Water hyacinths, Paddy straw, Bamboo leaf) influenced more than chemical mulch (Silver colour plastic). Mulches help in water conservation in turmeric production as well as promote increasing of plant growth, which is reflected in the yields. Thus biological mulch should be used for better rhizome yield. Among all the biological mulch treatments, turmeric cultivation with Bamboo leaf mulch produced the highest yield.

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