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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(4): 596-599

www.thepharmajournal.com
Received: 15-02-2021
Accepted: 18-03-2021

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Studies on the effect of weed management practices on soil parameters and availability of N, P, and K under turmeric (*Curcuma longa* L.)

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Abstract
An experiment was conducted to evaluate the effect of weed management practices on soil pH, bulk density, organic carbon and availability of N, P, and K during 2016-17 at A. N.D.U.A. &T., Kumarganj, Ayodhya. The result showed that maximum decline in soil pH, B.D. and increase in organic carbon status and maximum buildup of availability of N, P, K observed in the treatment applying paddy straw mulch @ 10 t/ha followed by 5 t/ha paddy straw mulch as compared to non-mulched treatments of 4 H.W. alone, integrated Herbicide (Metribuzin as P.E.) with two H.W. and weedy check. The treatment consisting of paddy straw mulch @ 10 t/ha found most superior in improving physico-chemical property and availability of N.P.K.

Keywords: paddy straw mulch, physico chemical property, availability of N, P, K.

Introduction
Turmeric (*Curcuma longa* L.) is a herbaceous plant belonging to family Zingiberaceae and order Scitaminae. It contains appreciable quantities of proteins (6.3%), lipids (5.1%), minerals (3.5%) carbohydrates (69.4%) and fibre (2.6%). Turmeric is rich in minerals like phosphorus, calcium, iron and vitamin A.

India contributes to about 78% of turmeric production followed by China 8%, Myanmar 4%, Nigeria and Bangladesh combindly 6% of total global production. In India, it is grown over an area of 0.186 million ha with a production and productivity of 0.943 million tonnes and 5.07 t/ha, respectively (Ministry of Ag. 2015-16) [11]. Application of mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and reduces water evaporation. Thus, it facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Kumar *et al*., 1990) [8].

Materials and Method
The experiment was carried out at Agronomy Research Farm, Kumarganj, Ayodhya during *Kharif* season 2016-17. The experiment was laid out in Randomized Block Design. The soil of experimental was slightly alkaline in reaction (pH 8.25), low in organic manure (4.5 g/kg) and available N (198 kg/ha), medium in available P (20.1 kg/ha), and high available K (321 kg/ha). The turmeric variety 'Narendra Haldi-1' was planted at 45 × 10 cm spacing on 24th June 2016. The 100% recommended dose of nitrogen (120 kg/ha) applied uniformly through farm yard manure.

To assess the various treatment effects, soil sample were collected after harvest of the crop from each plots. Soil pH and EC were determined by following Chopra and Kanwar (1991) [2]. Soil organic carbon was determined by Walkley and Black (1934) [18] rapid titration procedure. Soil available N was determined following Subbiah and Asija (1956) [17]. Available P was determined by Olsen *et al.* (1954) method. Available K was determined by following Jackson (1973) [7]. There were five treatments and four replications. The details of treatments are given below:

Table: Treatment details and symbols used

Symbol	Details	Short form
T_1	Paddy straw mulch @ 5 t/ha	5 t M
T_2	Paddy straw mulch @ 10 t/ha	10 t M
T_3	Hand weedings at 30,60,90 and 120 days after planting (DAP)	4 HW
T_4	Herbicide (Metribuzine) @ 750gm/ha followed by two hand weedings on 45 and 75 days after planting (DAP)	Herb.+ 2 HW
T_5	Weedycheck	WC

The experimental data analyzed using 'Analysis of Variance technique' in Randomized Block Design. The critical differences at 5 per cent of probability were calculated for testing the significance of difference between any two means where 'F' test was significant.

Result and discussion

Soil pH

The treatments consisting of paddy straw mulch @ 5 and 10 t/ha showed more decline in soil pH as compared to other conventional weed management treatments *viz.* Four hand weedings alone and integrated with herbicide (metribuzin) and two hand weedings. The results revealed that soil pH decreased with increasing the level of mulch from 5 to 10 t/ha (Table 1). There was no significant variation found between four hand weedings alone and integrated with herbicide (metribuzin) and hand weedings. The minimum declining of soil pH (8.10) was found in the treatment of weedy check. Mulch induced pH reduction, results from the addition or retention of organic matter, with organic acids produced from decomposition of plant-derived materials accumulating or leaching into the soil (Himelick and Watson, 1990) [7]. Alharbi Abdulaziz (2015) [1] also reported that organic mulches cause reduction in pH of the underlying soil.

Bulk density

The treatment consisting mulch of paddy straw @ 5 and 10 t/ha showed 5.2 and 5.8% reduction in bulk density over the initial value of 1.53 Mg/ m^3 (Table 1). The application of mulch resulted significant reduction in bulk density as compared to other non-mulched treatments *viz.* four hand weedings alone and integrated approach of herbicide (metribuzin) with two hand weedings. There was no significant variation in bulk density values between four hand weedings alone and integrated approach of herbicide (metribuzin) with two hand weedings. The highest bulk density (1.52 Mg/m^3) found in the treatment of weedy check. Ogbodo (2010) [12] reported that the reduction in soil bulk density might be due to product of mulch decompositions (polysaccharide and humus) acted as binding material on the soil particle hence improving soil pore volume, aggregation, structure and reducing the density per unit volume of soil. The improved soil structure owing to reduce soil bulk density. Pervaiz *et al.* (2009) [14] also observed that application of mulch decreased the bulk density (1.35 Mg m^{-3}) as compared to control.

Organic carbon

The treatment consisting of mulch material paddy straw @ 5 and 10 t/ha showed higher organic carbon (8.3 and 20.0%) as compared to the organic carbon in conventional treatment of four hand weedings alone which was statistically at par to the treatment integrated with herbicide (metribuzin) followed by two hand weedings (Table 1). The results revealed that organic carbon increased with increasing the level of mulch from 5 to 10 t/ha. There was no significant variation found between four hand weedings alone and integrated with herbicide (metribuzin) and hand weedings. The minimum organic carbon content (5.1 g/kg soil) was recorded under treatment of weedy check. Kumar *et al.* (2014) [9] reported that the increase in bacterial colonies in mulched plots may be the reason of increasing organic carbon content of soil, which is considered as one of the major constituents of food supply for bacteria (Shashidhar *et al*., 2009) [15]. It may be possible that consistent application of mulch may lead to continuous change in microbial community structure and species diversity with enhancement in soil organic matter. Pervaiz *et al*. (2009) [14] also observed that application of mulch resulted more soil organic matter (1.32 g/kg) as compared to control. Alharbi Abdulaziz (2015) [1] also reported that application of mulch increased the organic matter content in organic palm farming.

Available Nitrogen

Data depicted in the table 1 showed that the treatments mulching with paddy straw @ 5 and 10 t/ha showed superiority by maintaining higher available soil nitrogen than other weed management treatments *viz.* receiving four hand weedings alone and integrated with herbicide (metribuzin) and two hand weedings. Mulching with @ 5 and 10 t/ha build up more available soil nitrogen 28.8 kg/ha and 41.30 kg/ha, respectively, over the initial value of 198.0 kg N/ha. While conventional practice of four hand weedings alone and integration of herbicide and two hand weedings resulted an increase of 14.4 and 8.3 kg N/ha, respectively, over initial value. The results revealed that available N significantly increased with increasing the level of mulch from 5 to 10 t/ha. There was no significant variation observed between four hand weedings alone and integrated with herbicide (metribuzin) and two hand weedings. The availability of nitrogen was lowest (203.4 kg N/ha) in the treatment of weedy check. Kumar *et al*. (2014) [9] reported that mulching significantly increased the available nitrogen as compared to unmulched plots, might be due to microbial decomposition of organic material with large amount of liable organic nitrogen (N) which is expected to result in high rates of N mineralization (Forge *et al*., 2003) [4].

Available Phosphorus

Among the different weed management treatments, mulch treatments of paddy straw @ 5 and 10 t/ha showed superiority by observing higher available phosphorus over non mulch treatments *viz*. hand weedings alone and integrated with herbicide metribuzin and along with two hand weedings (Table 1). Mulching with 5 and 10 t/ha paddy straw build up more available phosphorus by 9.1 and 11.8 kg/ha, respectively, over the initial value of 20.1 kg P/ha, while 6 and 4.8 kg P/ha increase was found in the treatments conventional hand weedings alone and integrated with herbicide and hand weedings. There was no significant variation between four hand weedings alone and integrated approach of herbicide (metribuzin) with two hand weedings.

The lowest available phosphorus (21.6 kg P/ha) was recorded in the weedy check. The organic acids produced during the decomposition of mulching materials complexed metal cations Ca, Al and Fe, hereby helping in solubilization of native P and reduction in P sorption (Dahiya and Malik, 2002) [3]. Kumar *et al.* (2014) [9] also reported that application of pine needle mulch showed significantly higher available P as compared to unmulched plot.

Available Potassium

The different weed management treatments in which paddy straw mulch was applied @ 5 and 10 t/ha showed higher buildup of available potassium 38.7 and 55.2 kg/ha, respectively, over initial value (321.0 kg K/ha) as given in the table 1. While the treatments having only four hand weedings alone and integrated with herbicide (metribuzin) and two hand weedings showed buildup of 23.30 and 18.30 kg K/ha, respectively, over initial status. There was no significant variation between four hand weedings alone and integrated approach of herbicide (metribuzin) with two hand weedings. The minimum availability of potassium (331.2 kg/ha) found in the treatment of weedy check. The soluble potassium has been greatly increased by mulches, especially by straw mulch as the potassium of plant material is relatively readily soluble and leaches into soil. The effect is greater in the surface soil immediately under the mulch. Kumar *et al.* (2014) [9] also reported that application of popular mulch showed significantly higher available K as compared to unmulched plot. Alharbi Abdulaziz (2015) [1] also reported that application of mulch increased the available potassium in organic palm farming.

Table 1: Effect of weed management practices on soil property and availability of N, P, K

Treatment	Bulk density (Mg/m^3)	Soil pH (1:2.5)	Organic carbon (g/kg soil)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T_1: 5 t M	1.45	7.94	6.5	226.8	29.2	359.7
T_2 10 t M	1.44	7.88	7.2	239.3	31.9	376.2
T_3: 4 HW	1.49	8.04	6.0	212.4	26.1	344.3
T_4: Herb.+ 2 HW	1.51	8.07	5.9	206.3	24.9	339.0
T_5: WC	1.52	8.10	5.1	203.4	21.6	331.2
SEm±	0.01	0.026	0.117	3.51	0.88	4.67
CD (P=0.05)	0.03	0.08	0.36	10.80	2.72	14.40
Initial value	1.53	8.25	4.50	198.0	20.1	321.0

Conclusion

On the basis of results, it may be concluded that the influence of various organic mulches and different thicknesses of the mulch layer on the content of organic Carbon, soil pH and B.D. in the soil was evaluated. A higher content of SOC and maximum decline of soil pH and B.D. was observed in all mulched plots of paddy straw @ 5 t/ha and 10 t/ha as compared to the unmulched plots. Similarly, the maximum buildup of availability of nitrogen, phosphorus and potassium in mulched plots of paddy straw @ 5 t/ha and @10 t/ha as compared to unmulched plots.

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