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Effect of crop residues on productivity, profitability and oil quality of Indian mustard (*Brassica juncea* L.)

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Abstract

The present study was conducted to assess the effect of tree/ crop residues on productivity, profitability and oil quality of Indian mustard in Alfisol during 2020-21. The results showed that application of *Terminalia tomentosa* residue @ 5 t/ha was significantly noted maximum seed yield (384.3 kg/ha), protein content (20.21 %), oil content (48.1 %), oil yield (184.4 kg/ha) and yield attributes *viz.* no. of seeds per siliqua (7.81), length of siliqua (3.55 cm), no. of siliquae per plant (136.3), weight of seeds per plant (8.15) and 1000-seeds weight (2.65 g) of mustard than the other treatments. The same treatment also resulted the maximum economic returns and B:C ratio for mustard. Therefore, the application of *Terminalia tomentosa* residue @ 5 t/ha can be beneficial in enhancing the productivity and profitability of the mustard for the farmers.

Keywords*: Crop/tree residues, Indian mustard, oil yield, profitability, productivity*

Introduction

Crop residues, in general are parts of the plants left in the field after harvest of crops. Tree's residues are also important source of nutrients which can be recycled for improving the crop productivity and soil health. These materials have been regarded as farm waste/litters/ agroforestry farm waste that require disposal, but it has become increasingly realized that they are important natural resources and not wastes. The recycling of crop residues has the advantage of converting the surplus farm waste into useful product for meeting nutrient requirement of crops. It also maintains the soil physical and chemical properties and improves the overall ecological balance of the crop production system (Mandal *et al*., 2004). Crop residues may be incorporated partially or completely in to the soil depending upon methods of cultivation. Ploughing is the most efficient residue incorporation method. A large amount of crop residue is annually produced in the country like India. There is huge potential of recycling these crop residues in the crop production systems. Total production of crop residue in India is estimated at 350×10^6 kg/year. Impact of decomposing farm *in-situ* and *ex-situ* various agroforestry crop residues in soil reflected on residual effect of nutrients in soil. By addition of nutritious residues in soil which helps to developed soil fertility and build-up soil carbon, and also with the helps to improved productivity of any crops/plants (Adams and Angradi, 1996; Meshram *et al*., 2020). Crop residues management and recycling of agroforestry farm waste in soil is the major pathway for the return of organic matter and nutrients from aerial parts of the plant community to the soil surface and has an important bearing on soil formation and fertility and also fundamental process in nutrient cycling and it is the main means of transfer of organic matter and mineral elements from the farm waste to the soil surface (Odiwe and Muoghalu, 2003). Information is needed about crop residues management effects on carbon mineralization and nutrient availability in soil. In contrast, most of the farmers in Konkan Region of Maharashtra are doing "*rabbing*" practices which causes heavy metal in soil and harmful for balancing the environments and soil health. Instead of "*rabbing*", farmers can be using crop residues incorporation directly in the soil may be helps for long-lasting development of soil and crop health. Therefore, considering the urgent need to restore soil fertility and improving crop productivity by easily available agroforestry crop residue sources that occurs in most parts of the Konkan region of Maharashtra. *Terminalia tomentosa, Acacia auriculiformis, Acacia mangium, Glyricidia sepium, Mangifera indica, Anacardium occidentale, Synzygium cumini, Oryza sativa* and *Eleucine coracana* as being selected and easily available crop residues species on farmers field for the present study. This study was taken on the basis of high local and regional importance. Crop residues management will be definitely beneficial in future. With

this background, the present study was undertaken to study the effect of incorporation of crop residues on productivity, profitability and oil quality of Indian mustard.

Materials and Methods

An experiment was conducted at Dr. BSKKV, Dapoli, Maharashtra during 2020-21 on residue recycling on long-term basis which was started in 2016-17. The present investigation was framed in randomized complete block design with ten treatments and three replications *viz.* T_1- *Terminalia tomentosa,* T_2- *Acacia auriculiformis,* T_3- *Acacia mangium,* T_4- *Gliricidia sepium,* T_5- *Mangifera indica,* T_6- *Anacardium occidentale,* T_7- *Syzigium cumini,* T_8- *Oryza sativa,* T_9- *Eleucine coracana and* T_{10}- Control (without residue). The 'varuna' variety of the Indian mustard was used for the experiment. Mustard crop was grown during *rabi* season and recorded the effect of crop residues incorporated (5 t/ha) in the month of April 2020. Treatment wise plant samples of mustard were collected. The plant was firstly cleaned by rinsing with detergent followed by 0.02 N HCl and deionized water. After cleaning the plant, they were air dried and oven dried at 70 ^{0}C for 12 hours and they were ground in electrically operated stainless steel blades grinder up to maximum fineness. The ground samples were stored in polythene bags with proper labelling for chemical analysis. At harvest, straw and grain yields were recorded and these plant components were further used for chemical analysis. Yield attributes were recorded randomly from selected five plants from each plot at harvesting stages *viz*. number of seeds per siliqua, number of siliquae per plant, weight of seeds per plant, length of siliqua and 1000-seeds weight (g). The crop was harvested from each net plot and carefully recorded the grain yield and calculated by multiplying net plot size and converted on hectare basis as kg/ha. The oil content of mustard was determined by soxhlet extraction method using petroleum ether as an extractant (Plummer, 1998). The nitrogen content in seed defatted was determined by Micro-Kjeldhal's method. Protein content was calculated by multiplying per cent nitrogen with the factor 6.25 for mustard. Similarly, oil yield was calculated by multiplying the oil content with grain yield of the respective treatment. Overall experimental data was analyzed by DBSKKVSTAT software and used guideline as given by Panse and Sukhatme (1985). The agroforestry residues were analyzed for nutrient and lignin content and data has been presented in Table 1.

Table 1: Nutrients, lignin compositions and C:N ratio of tree/ crop residues

Treatment	C (%)	N (%)	P (%)	K (%)	Lignin (%)	C:N ratio
T. tomentosa	61.23	1.58	0.87	0.98	12.29	38.75
A. auriculiformis	68.56	1.06	0.11	0.28	34.17	64.68
A. mangium	64.71	1.17	0.18	0.39	31.36	55.31
G. sepium	58.94	2.04	0.52	0.71	8.10	28.89
M. indica	59.86	1.26	0.28	0.68	14.76	47.51
A. occidentale	60.79	0.94	0.17	0.54	21.82	64.67
S. cumini	54.26	0.98	0.23	0.73	18.35	55.37
O. sativa	37.09	0.39	0.05	0.47	7.43	95.10
E. coracana	35.56	0.38	0.07	0.53	9.17	93.58

Results and Discussion

Growth and yield attributes

The plant height of mustard was recorded during flowering stage and it was recorded statistically significant over the control (Table 2.) The maximum height was observed by *T. tomentosa* residue @ 5 t/ha (146.7 cm) followed by *G. sepium* residue @ 5 t/ha (146.5 cm) which were found to be at par with each other. The lowest height was recorded in control (109.7 cm). Similar findings were recorded by Sharma *et al.* (2017) with the application of organic sources increased height of mustard, and also Jadhav (2018) reported that incorporation of *G. sepium* residue @ 5 t/ha in soil recorded maximum height of mustard crop. Significantly higher improvement in the yield attributes of mustard *viz*. number of seeds per siliqua (7.81), number of siliquae per plant (136.3) and weight of seeds per plant (8.15) was observed with the incorporation of *T. tomentosa* residue @ 5 t/ha than other treatments. Whereas, the maximum length of siliqua (3.55 cm) and 1000-seeds weight (2.65 g) were also noticed with the incorporation *T. tomentosa* residue @ 5 t/ha but its effects were observed statistically non-significant (Table 2). Kansotia *et al.* (2015) reported that organic sources improved soil organic matter status which act as a reservoir for nutrients and it improves soil physicochemical and crop yield attributes. The increase in the yield attributes might be due to increased absorption of nutrients from the soil resulting to maintain nutrients mobility and the formation of reproductive

Table 2: Effect of tree/ crop residues on yield attributing characters of Indian mustard

Treatment	Plant height (cm)	No. of seeds/ siliqua	Length of siliqua (cm)	No. of siliquae/ plant	Weight of seeds/ plant	1000-seeds weight (g)
T. tomentosa	146.7	7.81	3.55	136.30	8.15	2.65
A. auriculiformis	124.7	6.23	3.28	99.33	6.50	2.37
A. mangium	125.4	6.46	3.30	115.16	6.83	2.42
G. sepium	146.5	7.80	3.54	129.15	8.13	2.64
M. indica	136.2	7.37	3.37	121.74	7.60	2.52
A. occidentale	131.1	7.28	3.34	115.00	7.33	2.44
S. cumini	129.3	7.47	3.45	127.67	7.72	2.55
O. sativa	139.8	6.47	3.34	118.33	7.53	2.48
E. coracana	137.0	6.58	3.37	120.83	7.55	2.49
Control	109.7	6.17	3.03	90.19	5.63	2.30
SEm±	6.64	0.25	0.09	4.46	0.28	0.12
CD (p= 0.05)	20.03	0.75	NS	13.26	0.85	NS

structure in plant which plays a vital role in improving the vegetative structure for nutrient absorption and provides strong sink through the development of reproductive structure as well as the production of assimilates to fill economically important sink (Basumotary *et al*., 2020).

Quality parameters

The data of mustard oil content and oil yield has given in (Table 3). Significantly higher oil content and oil yield of mustard seed was recorded by *T. tomentosa* residue @ 5 t/ha (48.07 % and 184.40 kg/ha) followed by *G. sepium* residue, *A. mangium*, *M. indica* and *S. cumini* which were found to be at par with each other. The lowest mustard oil content and oil yield was recorded in absolute control (43.01 % and 83.25 kg/ha). This might be due to that the role of native and residues sulphur source in synthesis of oil. Sulphur is involved in the formation of glucosides and glucosinolates and activation of enzymes which aid in some important biochemical reactions in the plant (Meshram *et al*. 2019). Jadhav (2018) observed that the incorporation of *G. sepium* residue @ 5 t/ha results in highest oil content (40.64 %) in mustard.

Application of crop residues in soil was significantly improved protein content in mustard grain (Table 3). Significantly maximum protein content in mustard seed (20.21 %) was recorded by *T. tomentosa* residue @ 5 t/ha followed by *G. sepium* residue @ 5 t/ha (20.07 %) which was found to be at par with each other. The lowest value of protein was recorded in absolute control (17.08 %). It might be due to that the role of sulphur in protein synthesis, as sulphur is a constituent of essential amino acids *viz*. methionine, cysteine and cysteine (Meshram *et al*. 2019). It also helps in conversion of these amino acids in to high quality protein.

Table 3: Effect of tree/ crop residues on oil content, oil yield and protein content in seed of mustard

Treatment	Oil content (%)	Oil yield (kg/ha)	Protein (%)
T. tomentosa	48.07	184.40	20.21
A. auriculiformis	44.03	114.70	17.54
A. mangium	43.75	123.61	18.33
G. sepium	44.31	167.80	20.07
M. indica	43.14	149.44	19.83
A. occidentale	41.99	120.50	18.42
S. cumini	43.25	151.27	19.72
O. sativa	42.04	123.67	18.46
E. coracana	40.09	117.00	18.40
Control	39.41	83.25	17.08
SEm±	0.37	14.44	0.19
CD (p= 0.05)	1.11	42.92	0.58

Grain and straw yields

Application of crop residues significantly enhanced mustard grain and straw yields over the control in *Alfisol* (Table 4). The maximum grain yield (384.3 kg/ha) was obtained with incorporation of *T. tomentosa* residue @ 5 t/ha followed by *G. sepium* (378.8 kg/ha), *S. cumini* (350.2 kg/ha) and *M. indica* (346.2 kg/ha) residues @ 5 t/ha of each which were found to be at par with each other. *Terminalia tomentosa* residue @ 5 t/ha incorporation in soil recorded 172.6 kg/ha more grain yield of mustard than the absolute control. Similar trend was found in case of straw yield of mustard. The maximum straw yield (1165.1 kg/ha) was recorded with the incorporation of *T. tomentosa* residue @ 5 t/ha followed by *G. sepium* (1056.1 kg/ha), *S. cumini* (1030.8 kg/ha) and *M. indica* (1018.6 kg/ha) residues @ 5 t/ha of each which were found to be at par with each other. The lowest grain and straw yields were observed in control. Saha *et al*. (2010) reported that the application of 3 t/ha crop residues for mustard have been improved yields of crop. Similarly, Kharub *et al.* (2004) and Mandal *et al*. (2004) and Sharma *et al.* (2017) reported that the application of crop resudues/organic sources were recorded significantly higher yield of of crop. Moreover, Chatterjee *et al*. (2017) studied that application of crop residues @ 0-10 t/ha was significantly increased crop yield.

Table 4: Yield and economics of mustard under different crop residues management practices

Treatment	Grain yield(kg/ha)	Straw yield(kg/ha)	GMR (Rs./ha)*	NMR (Rs./ha)	B : C ratio
T. tomentosa	384.3	1165.1	30398	5981	1.23
A. auriculiformis	261.2	771.9	20585	-2197	0.90
A. mangium	282.2	870.6	27019	3164	1.13
G. sepium	378.8	1056.1	29675	5378	1.22
M. indica	346.2	1018.6	27276	3379	1.14
A. occidentale	287.2	690.2	22160	-885	0.96
S. cumini	350.2	1030.8	27592	3643	1.15
O. sativa	294.5	951.0	23456	196	1.00
E. coracana	292.3	930.1	23253	26	1.00
Control	211.7	666.7	16817	-5337	0.76
SEm±	33.3	57.3	2759	2706	0.09
CD (p= 0.05)	98.9	170.3	8199	8658	0.28

*Market selling price of mustard sed was Rs. 7000 per quintal

Economics

Significantly higher gross monetary returns (GMR), net monetary returns (NMR) (Rs. 30398 and 5981/ha) and benefit cost (B:C) ratio (1.23) of mustard were recorded with the incorporation of *T. tomentosa* residue @ 5 t/ha over the control (Table 4). Application of only organic sources in soil had beneficial effect on getting optimum returns from mustard may be due to reduced cost and higher yield which ultimately also improved the benefit-cost ratio by particular management practices in soil (Sharma *et al.*, 2017; Meshram *et al*., 2019).

Conclusion

It can be concluded that the incorporation of *Terminalia tomentosa* residue @ 5 t/ha or *Glyricidia sepium* residue @ 5 t/ha enhanced the productivity, productivity, oil yield, quality and profitability of the Indian mustard in Alfisol soils.

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