JOURNAL OF PURE AND APPLIED MICROBIOLOGY, Nov 2015. Vol. **9**(Spl. Edn. 2), p. 273-278

Effect of Tillage and Organic Mulches on Yield Attributes and Economics of Mustard Crop under Rainfed Condition of Mirzapur District (U.P.)

M.K. Singh, Ramawatar Meena*, R.N. Meena[1], Balu Ram, R.K. Meena, M.K. Verma and Avinash Rai

Department of Soil Science and Agricultural Chemistry, I.Ag.Sc, BHU, Varanasi, India.
[1]Department of Agronomy, I.Ag.Sc, BHU, Varanasi, India.

(Received: 16 July 2015; accepted: 06 October 2015)

The present study was carried out to evaluate the effectiveness of conservation tillage under "Effect of tillage and organic mulches on yield attributes and economics of mustard crop in rainfed condition of mirzapur district (U.P.)" during the period from November 2012 to April 2013at the Agronomy farm of Rajiv Gandhi South Campus, Barakachha (BHU), Mirzapur which is situated in Vindhyan region of district Mirzapur.. The study included conventional tillage and reduced tillage conditions and three indigenous mulches viz. water hyacinth, paddy straw, and legume straw. The experiment was conducted in split plot design viz. tillage practices (conventional tillage and reduce tillage) in main plots and mulching practices under sub plot (no mulch, water hyacinth mulch, paddy straw mulch and legume straw mulch).Mulching practices also enhanced the number of siliqua plant^{-1}, siliqua length, number of seed siliqua^{-1} and 1000-grains weight, grain yield and higher harvest index (HI). The grain yield of mulched plants notably water hyacinth was (1419.23 kg ha^{-1}) than unmulched plants (1154.06 kg ha^{-1}) under reduce tillage condition.

Key words: Economics, Mulching, Mustard, Tillage, Yield & Yield Attributes.

Food security is challenged by increasing global population, climate change, and resource shortages, Leitner *et al* (2014) and Rockstrom *et al* (2007). In particular, severe water scarcity occurs in 45% of the global land resources, Safriel *et al*. (2005). Subsoil tillage (ST) and straw mulching are typical cultivation methods used to improve crop yields in arid areas, Hou *et al* (2012) and Verhulst *et al* (2011). Mulches have favourable effect on physical, chemical and biological properties of soil by stabilizing soil, aggregates, enhancing soil organic matter, soil nutrients and reducing run off and soil erosion by intercepting rain drops. Mulching is the process of covering the surface soil with various mulching materials such as straw, dry leaves, stubbles, cut grasses, polyethylene etc. Soil moisture is the major limiting factor for crop production under rainfed situation, therefore, moisture conservation is important to achieve higher yield. Among the various soil moisture conservation practices, mulching is one of the technology is assuming greater importance. Further, mulching reduces evaporation, checking down weeds and there by enhance infiltration of water. Further it moderates wide fluctuation in soil temperature too. Green manuring also play an

* To whom all correspondence should be addressed.
E-mail: rmeena78@gmail.com

important role in soil and moisture conservation and improvement of soil properties.

Tillage plays a vital role in plant growth at different stages under rainfed cultivation. It also improves soil condition by altering the mechanical impedance to root penetration, hydraulic conductivity and holding capacity, which in turn affects plant growth, Dexter (1989). The effect of mulch on soil temperature, moisture regime and root growth as well as yield depend on the climatic environment, made of mulch application and quality and quantity of mulch materials.

Mustard is an important *rabi* oilseed crop in India. It occupies about 24.70 per cent of area and 48.28 per cent of production of the total oilseed production in India. Its area, production and productivity in the country is 5.43 M. ha, 6.41 Million tonnes & 1159 kg ha^{-1}, respectively. In Rajasthan state the total area under mustard cultivation is 2.84 M.ha with the estimated production of 3.5 M. tonnes & average productivity of mustard in the state is 1234 kg ha^{-1}, Anonymous (2010).

MATERIALS AND METHODS

The experiment was carried out at the Agronomy farm of Rajiv Gandhi South Campus, Brakachha (BHU), Mirzapur which is situated in *Vindhyan* region of district Mirzapur (25º 10' latitude, 82º 37' longitude and altitude of 427 meters above mean sea level) occupying over an area of more than 1000 ha. *Vindhyan* soil comes under rainfed and invariably poor fertility status. This region comes under agro-climatic zone III A (semi-arid eastern plain zone). The climate of Barkachha is sub-humid, characterized by extremes of temperature both in summer and winter with medium rainfall. Maximum temperature in summer (May) is reached up to 39.85°C and minimum temperature in winter (January) falls below 8.12°C. The average annual rainfall of locality is 1100 mm, of which nearly 90 per cent is contributed by South West monsoon between July to September and 10 percent rain fall in other months. The total rainfall and evaporation during the crop season 2012-13 was 53.55 mm and 43.9 mm; maximum and minimum temperature was 37.48ºC and 4.75ºC, and relative humidity was 96.28 and 83.96 per cent respectively.

On the basis of physical analysis soil was sandy loam in texture having Sand (50.1%), silt (37.2%), and clay (12.7%). The soil was moderately acidic in pH (5.7), having low salt concentration (EC 0.29 dSm^{-1}), medium in organic carbon (0.49 %), low available N (177.72 kg/ha), lower range in available P (9.34kg/ha), available K (113.31 kg/ha) and available sulphur (38.96 mg kg^{-1}). The experiment consisted of eight treatment combinations, involves application of Conventional tillage and No mulch (T_1M_0), Conventional tillage and Water hyacinth mulch (T_1M_1), Conventional tillage and paddy straw mulch (T_1M_2), Conventional tillage and legume straw mulch (T_1M_3), Reduce tillage and no mulch (T_2M_0), Reduce tillage and water hyacinth mulch (T_2M_1), Reduce tillage and paddy straw mulch (T_2M_2), Reduce tillage and legume straw mulch (T_2M_3). The experiment was conducted under two tillage systems viz., conventional tillage and reduces tillage. In this system seeds were sown in rows with the help of hand operated narrow blade (*Kudal*) by opening furrow, with spacing of 30 cm between two rows. Higher seed rate (5 kg ha^{-1}) was applied at 4 cm depth in open furrows made with a manual single row drill at a spacing of 30×10 cm and immediately covered with soil. The recommended dose of NPK & S fertilizers was 25:40:25:2 Kg/ha. Fifty percent of nitrogen and full dose of phosphorus, potassium and sulphur were applied at sowing and remaining 50% N was applied at the pre - flowering stage. After selection and cutting, samples were chopped and secured in paper bags for air drying in oven at 105^0C till constant weight. Total number of capsules on the tagged plants was counted and average number of siliquas per plants was computed. After selection of siliqua, they were broken carefully by hand and seed were counted and average number was computed. Length of five randomly selected siliqua was measured from five tagged plants and average computed. Randomly selected 1000-seed from the seed yield samples of the crop were counted from each plot and their combined weight was recorded to get the test weight of 1000 seeds. The Stover yield was computed by deducting seed yield from the respective bundle weight. The seed and stover yield (kg ha^{-1}) was converted to quintal per hectare. The cost of cultivation was worked out by taking into consideration all the expenses incurred. Net return (¹ ha^{-1}) and benefit: cost ratio

Table 1. Effect of moisture conservation measures on dry matter and yield attributes of mustard crop

Treatments	Plant dry matter (g)						Yield attributes			
	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	At Harvesting	Siliqua plant^{-1}	Siliqua length (cm)	Seeds siliqua^{-1}	1000-grain weight (gm)
Tillage										
Conventional tillage	0.3	0.73	11.86	20.15	29.69	33.82	154.6	5.41	13.4	6.15
Reduce tillage	0.34	0.76	12.51	20.56	30.88	35.73	186.52	5.67	13.68	7.53
SEm±	0.01	0.01	0.08	0.07	0.17	0.22	5.03	0.03	0.04	0.06
CD (0.05)	0.03	NS	0.46	0.4	1.06	1.33	30.59	0.18	0.25	0.36
Mulch										
No mulch	0.29	0.71	11.53	19.93	29.24	32.73	107.5	5.3	13.24	5.53
Water hyacinth mulch	0.34	0.76	12.65	20.71	31.04	36.57	207.27	5.75	13.78	7.81
Paddy straw mulch	0.33	0.76	12.34	20.49	30.54	34.95	188.13	5.59	13.65	7.17
Legume straw mulch	0.33	0.74	12.21	20.29	30.33	34.85	179.33	5.53	13.49	6.85
SEm±	0.01	0.01	0.09	0.15	0.19	0.33	6.95	0.04	0.06	0.17
CD (0.05)	0.02	NS	0.27	NS	0.6	1.02	21.42	0.13	0.2	0.53

Table 2. Response of moisture conservation measures on economics of mustard crop under rainfed condition

S. No.	Treatment	Cost of cultivation (¹ ha^{-1})	Gross return (¹ ha^{-1}) Grain	Stover	Total	Net return (‘¹ ha^{-1})	Benefit : cost ratio
1	T_1M_0	18635.38	39738.56	24545.37	64283.93	45648.55	2.4
2	T_1M_1	22635.38	46274.51	28578.98	74853.49	52218.11	2.3
3	T_1M_2	24885.38	44836.6	27691.59	72528.19	47642.81	1.9
4	T_1M_3	24885.38	43137.25	26642.85	69780.1	44894.72	1.8
5	T_2M_0	17835.38	41045.75	25352.09	66397.84	48562.46	2.7
6	T_2M_1	21835.38	53071.9	32773.94	85845.84	64010.46	2.9
7	T_2M_2	24085.38	50196.08	30999.15	81195.23	57109.85	2.4
8	T_2M_3	24085.38	47712.42	29466.38	77178.8	53093.42	2.2

was calculated with the help of the following formula:

Net return (¹ $ha^{-1)}$ = Gross return (¹ ha^{-1}) – Cost of cultivation (¹ ha^{-1})

Benefit : Cost Ratio = Net Return/ Cost of Cultivation

RESULTS AND DISCUSSIONS

Dry matter accumulation

The data on dry matter accumulation at different stages of observations under reduce tillage and conventional tillage with different mulches is presented in table 1. In the tillage system significantly higher dry weight $plant^{-1}$ (0.34, 12.51, 20.56, 30.88 and 35.73 g) were found under reduce tillage at 20, 60, 80, 100 DAS and at harvest cropping stages, respectively than conventional tillage, but the data at 40 DAS were found not-significant. The increase in dry matter accumulation might be due to significant increase in plant height, primary and secondary branches, which contributes to the dry weight of plant and ultimately resulted as dry matter accumulation, Ghosh *et al* (2010). The water hyacinth mulch was produced significantly higher (0.34, 12.65, 31.04 and 36.57 g) dry matter accumulation compare to no mulch treatment at 20, 60, 100 DAS and at harvest cropping stages. The mulches had non-significant effect on dry matter accumulation at 40 and 80 DAS stages of observations.

Yield attributes

Under tillage system, significantly more numbers of siliqua $plant^{-1}$ (186.52) was found with reduce tillage over conventional tillage (154.60). Among the different mulches, the water hyacinth mulch was produced significantly higher (207.27) number of siliqua $plant^{-1}$ compare to no mulch (107.5) while legume straw mulch was produced (179.33) number of siliqua $plant^{-1}$ (Table 1). Length of siliqua in mustard plant increased significantly with reduced tillage (5.67 cm) system over conventional tillage (5.41 cm) however, highest siliqua length(5.75cm) was found with water hyacinth mulching compare to rest of mulching treatments and minimum siliqua length(5.30 cm) was found in control. In the tillage system maximum seedssiliqua^{-1}(13.68) was found in reduce tillage over conventional tillage (13.40). Number of seeds increased per siliqua due to more length of siliqua under the reduced tillage condition, Katiyar (2002). Water hyacinth mulch was also found significantly in (13.78) seeds $siliqua^{-1}$ compare to other mulching treatments and minimum seeds $siliqua^{-1}$ was found in control condition (13.24).In the similar way of treatments 1000 grain weight(7.53 g) was observed under reduced tillage than conventional tillage (6.15 g), Cepeda and Gomez (2010). The maximum test weight (7.81 g) of mustard seed was found under water hyacinth mulching compare to rest of other mulching treatments and minimum test weight (5.53 g) was recorded under no mulch, Sarangi *et al* (2010).

Grain yield

The yield of mustard grain under reduce tillage condition was recorded 1371.62 kg ha^{-1} while 128.86 kg less yield (1242.76 kg ha^{-1}) was recorded under conventional tillage system. The similar trend

Table 3. Effect of moisture conservation measures on grain yield, stover yield and harvest index of mustard crop

Treatment	Grain Yield (kg.ha^{-1})	Stover Yield (kg.ha^{-1})	Harvest index (%)
Tillage			
Conventional tillage	1242.76	4636.83	21.13
Reduce tillage	1371.62	4845.08	22.02
SEm±	12.89	18.65	0.15
CD (0.05)	78.40	113.48	0.90
Mulch			
No mulch	1154.06	4364.50	20.91
Water hyacinth mulch	1419.23	4975.33	22.16
Paddy straw mulch	1357.61	4861.50	21.81
Legume straw mulch	1297.85	4762.50	21.40
SEm±	21.82	26.67	0.29
CD (0.05)	67.22	82.18	0.90

was found in case of stover yield of mustard, 4845.08 kg and 4636.83 kg ha^{-1} under reduced and conventional tillage system, respectively, Toth *et al* (2011). Among different mulching practices, the water hyacinth mulch was produced significantly higher (1419.23 kg ha^{-1}) grain yield (1154.06 kg ha^{-1}) over control, Verma *et al* (2011). The effectiveness of mulches with regards to grain and stover yield of mustard was in the order of water hyacinth>paddy straw>legume straw>control. The water hyacinth mulch was recorded significantly better (22.16 per cent) over control, but also found statistically at par to paddy straw and legume straw mulching.

Economics

The maximum grain and stover monetary returns were observed under reduced tillage system (Table 2). Under different mulches,cost of cultivationunder reduced tillage system with water hyacinth mulch was ₹ 21835.38whereas maximum gross return, net return and benefit cost ratio were ₹ 85845.84, ₹ 64010.46, and 2.9 respectively, Yadav et al (2011).

CONCLUSIONS

Water hyacinth mulch under reduced tillage system was the most effective approach to improve the plant growth and economics of the inputs. Yield attributes of mustard *viz*;siliqua per plant, siliqua length, seed per siliqua and 1000 grain weight were improved significantly with water hyacinth mulching.Grain and stover yield of mustard was significantly higher when the crop was sown with water hyacinth mulching in reduced tillage field. The maximum net returns and benefit: cost ratio was recorded under water hyacinth mulch with reduced tillage.

ACKNOWLEDGEMENT

The authors are thankful to the Head, Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for providing necessary facilities to conduct this research work.

REFERENCES

1. Leitner, D., Meunier,F., Bodner,G., Javaux, M.,Schnepf, A. Impact of contrasted maize root traits at flowering on water stress tolerance—a simulation study. *Field Crops Res*, 2014; **165**: 125–137.
2. Rockström, J., Lannerstad, M., Falkenmark, M.(2007) Assessing the water challenge of a new green revolution in developing countries. *Proc Natl Acad Sci, U.S.A.*, 2007; **104**: 6253–6260.
3. Safriel, U., Adeel, Z., Niemeijer, D., Puigdefabregas, J., White, R., Lal, R., Winslow, M., Ziedler, J., Prince, S., Archner,E., King, C. Dryland systems, in: R. Hassan, R.J. Scholes, N. Ash (Eds.), Eco human well-being, Findings of the Conditions Trends Working Group of the Millennium Eco Assessment, *Vol. 1, Island Press, Washington D.C., U.S.A.*, 2005; 623–662.
4. Hou, X.Q., Li, R., Jia, Z.K., Han, Q.F., Yang, B.P., Nie, J.F. Effects of rotational tillage practices on soil structure, organic carbon concentration and crop yields in semi-arid areas of northwest China. *Soil Use Manag*, 2012; **28**: 551–558.
5. Verhulst, N.,Nelissen, V., Jespers, N., Haven,H., Sayre, K.D., Raes, D., Deckers, J., Govaerts, B. Soil water content, maize yield and its stability as affected by tillage and crop residue management in rainfed semi-arid highlands. *Plant Soil*, 2011; : 73–85.
6. Dexter, A.R.. Soil mechanics relation to tillage implements and root penetration in lowland soils. In Soil Physics and Rice. *Int Rice Res Inst*, 1989; **105**: 261-281.
7. Anonymous. Agricultural statistics at a glance. *Directorate of Econ & Stat, Dept of Agril & Corp, New Delhi*, 2010;pp: 32-39.
8. Ghosh, P. K. Das, Anup, Saha, R. Tomar, J. M. S. Improving mustard yield through in-situ soil moisture conservation and conservation tillage in foot hills of Meghalaya. *Ind J of Soil Con*, 2010; **38**(3):184-187.
9. Katiyar, S. C. Effect of moisture conservation practices on mustard production under rainfed condition. *Bhartiya Krishi Anusandhan Patrika, 2002;* **17**(2/3):81-86.
10. Cepeda, M. A. Gomez, B. L. (2010) Response of canola (*Brassica napus*) at different conservation tillage in rainfed Purepecha Plateau. *Michoacan, Mexico,ITEA*, 2010; **106**(4):282-

293.
11. Sarangi, S. K., Saikia, U. S., Lama, T. D. Effect of rice (*Oryzasativa*) straw mulching on the performance of rapeseed (*Brassica campestris*) varieties in rice-rapeseed cropping system. *Ind. J of Agric Sci*, 2010; **80**(7):603-605.
12. Toth, Z., Dunai, A., Toth, I. M. Effect of soil tillage on moisture content and temperature of the soil in oilseed rape. *Novenytermeles*, 2011; **60**: 199-202.
13. Verma, C. K., Yadav, D. D., Kushwaha, K. P. Effect of fertilizers and moisture conservation practices in mustard (*Brassica juncea* L.) under rainfed condition. *Current Advances in Agric Sci*, 2011; **3**(2):108-111.
14. Yadav, P. N., Uttam, S. K., Singh, R. P., Kumar, Kaushal. Effect of soil water conservation practices on mustard for efficient water and nitrogen use in coarse textured soil. *Agropedology*, 2011; **17**(2):131-134.