International Journal of Agricultural and Applied Sciences, December 2022, 3(2): 60-64
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2022.3211

Research Article

OPEN ACCESS

Response of rainfed Indian mustard to different tillage practices and mulching

K. Nandini Devi[*1]; Naidu Bhargavi Naga Kalyani[1]; J. Lhungdim[1]; A. Herojit[1]; N. Gopimohan[1], KSH. Manishwari Devi[1] and A. Dorendro[2]
[1]*College of Agriculture, Central Agricultural University, Imphal, India*
[2]*Department of Botany, Mayai Lambi College, Manipur, India*
Corresponding author e-mail: nandinikcau@gmail.com
(**Received:** 05/08/2022; **Revised:** 30/10/2022; **Accepted:** 11/11/2022)

ABSTRACT
A field experiment was conducted during the *rabi* season of 2019 at College of Agriculture, Central Agricultural University, Imphal, Manipur. The experiment included the combination of two soil tillage systems viz., Conventional Tillage (L_1) and Minimum Tillage (L_2) and four different mulching materials viz., No mulch (M_1); Rice straw mulch (M_2); Polythene mulch (M_3) and Tree leave mulch (M_4). The Experiment was laid out in a split-plot design with different levels of tillage (main plot), and mulching materials (subplot) and each treatment were replicated thrice. The growth and yield of Indian mustard were influenced by different tillage practices and mulching. Maximum plant height (165.33 cm.), number of siliquae per plant (197) and seed yield (1790 kg/ha) and oil yield (692 kg/ha) were recorded in a combination of (L1M3) which received in Conventional tillage + Polythene mulch and minimum seed yield was recorded in a combination of (L2M1) 1441 kg/ha which received in Minimum tillage + No mulch. Maximum harvest index was recorded in a combination of (L1M2) 27.50% which was received in Conventional tillage +Rice straw mulch and minimum harvest index was recorded in a combination of (L1M4) 24.13% which was received in Conventional tillage + Tree leaves to mulch. The highest benefit-cost ratio (0.72) was recorded in Minimum tillage + Rice straw mulch because there was less input cost for tillage or ploughing activities and mulching material cost. The highest energy use efficiency, and energy productivity but lowest specific energy was observed in Minimum tillage with No mulch and energy use efficiency, and energy productivity but highest specific energy was observed in Minimum tillage with Rice straw mulch.
Keywords: Indian mustard, tillage, mulching, yield and energy.

INTRODUCTION
Among the edible *rabi* oilseeds of India, rapeseed-mustard is a major crop, being cultivated along with safflower, *rabi*- groundnut and *rabi*-sunflower. India holds a premier position in the rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production, respectively. The relatively high content (36-38%) and quality of protein make the rapeseed-mustard seed meal valuable raw material for food as well as the feed industry. The good amino acid composition often compared to milk protein, contributes to high nutritive value (Kumar, 2012). Minimum tillage which has the potential to break the surface compact zone in soil with reduced soil disturbance offers to lead to a better soil environment and crop yield with minimal impact on the environment (Busari *et al.,* 2015). Conventional tillage is a tillage system used as the major means of seedbed preparation and weed control. It includes a sequence of soil tillage, such as ploughing and harrowing, to produce a fine seedbed, and also the removal of most of the plant residue from the previous crop.

The application of mulching practices reduces water evaporation, conserves soil moisture, suppresses weed growth, controls soil structure and temperature, influences soil micro-organisms, and is aesthetically pleasing. The effects of mulching materials on crop yield, productivity and water use efficiency. Plastic mulching materials have greater importance than organic ones to control the soil environment and increase crop yield. But organic mulching materials are inexpensive and environment friendly (Kader *et al.,* 2017).
Keeping in view of the above facts, the present investigation was undertaken during *rabi* 2019-2020 at Research Farm, College of Agriculture, Central Agricultural University, Imphal with the objective of conserving soil moisture as well as preventing weed growth in the Indian mustard field.

MATERIALS AND METHODS
A field experiment was undertaken during the *rabi* season of 2019 at College of Agriculture, Central Agricultural University, Imphal, Manipur. The experiment included the combination of two soil tillage

systems viz., Conventional Tillage (L_1) and Minimum Tillage (L_2) and four different mulching materials viz., No mulch (M_1); Rice straw mulch (M_2); Polythene mulch (M_3) and Tree leave mulch (M_4). The Experiment was laid out in a split-plot design with different levels of tillage (main plot), and mulching materials (subplot) and each treatment were replicated thrice. The soil of the experimental field was clay with pH (5.40), organic matter (2.07%), available nitrogen (291kg/ha), available P_2O_5 (16.78kg/ha) and available K_2O (212.3kg/ha) respectively. The average rainfall received during the crop growth period was 31.06 mm. The crop was sown on 15th December 2019 and harvested on 20th April 2020. The recommended dose of N:P: K was 80:40:40 kg/ha. The fertilizers were used in the form of urea, single super phosphate and muriate of potash. Full dose of phosphorous and potash along with half dose of urea were applied uniformly as a basal to all the plots three days before sowing. The remaining half dose of nitrogen was applied in two equal splits at 30 DAS and 60 DAS respectively.

Energy use efficiency described the total amount of energy used on a farm (in the form of electricity, diesel, or other sources) compared to the amount of production.

$$\text{Energy use efficiency} = \frac{\text{Energy output } (\frac{GJ}{ha})}{\text{Energy input } (\frac{GJ}{ha})}$$

Energy productivity was estimated by comparing the yield of mustard to the energy input

$$\text{Energy productivity (kg/MJ)} = \frac{\text{The yield of mustard } (\frac{kg}{ha})}{\text{Energy input } (\frac{GJ}{ha})}$$

Specific energy was estimated by comparing energy input to yield of mustard.

$$\text{Specific energy (MJ/kg)} = \frac{\text{Energy input } (\frac{GJ}{ha})}{\text{Yield of mustard } (\frac{kg}{ha})}$$

Statistical analysis of data

The data obtained from the experiment were subjected to statistical analysis by adopting the analysis of variance technique (Fisher, 1950) for “Split plot design”. The significance of the difference among the treatment effect was tested through the ‘F’ test and critical difference (C.D.) at a 5% level of significance.

RESULTS AND DISCUSSION

Conventional tillage (L1) treated plots showed the highest plant height when compared to Minimum tillage (L2) plots. Plant height was recorded significantly higher in Conventional tillage (L1) practice (151.17 cm) compare to Minimum tillage (L2) practice (137.25 cm). This might be due to fine seedbed preparation in conventional tillage (L1) compared to Minimum tillage (L2) which leads to better root growth and deep root system development. This observation was supported by the work of Ved (2000), Kumar *et al*. (2016), and Mishra *et al.* (2019) in all these they had observed proper growth and development of plant was observed in conventional tillage plots.

The highest plant height was recorded under Polythene mulch (M3) followed by Rice straw mulch (M2) at all the stages of observation and the lowest plant height was recorded under No mulch (M1). This might be due to the better suppression of weed growth resulting in less competition and reduced loss of nutrients from the soil as compared to other treatments. The mulch help in weed suppression, increases soil fertility, maintains soil temperature and reduces leaching losses. This observation was supported by the work of Subrahmanyan *et al.* (2002), Yadav *et al.* (2006) Chinnathurai *et al.* (2012), Kader *et al.* (2017) and Anand *et al.* (2020).

Maximum plant height was recorded in a combination of (L1M3) which was received in Conventional tillage + Polythene mulch 165.33 cm. Minimum plant height was recorded in a combination of Minimum tillage + Rice straw mulch 131 cm. Mulching helps in the efficient utilization of resources like water, and nutrients, better suppression of weed growth, to maintain proper soil temperature and its properties which enhance the growth of beneficial microbes in soil cumulatively resulting in higher plant growth and yield development. This observation was supported by the work of Choudhary *et al.* (2017), and Mounika *et al.* (2020).

The number of primary branches per plant was recorded as significantly higher in Conventional tillage (5.29) as compared to Minimum tillage (4.08). This might be due to fine seedbed preparation in conventional tillage (L1) compared to Minimum tillage (L2) which leads to better crop growth and the development of mustard. This observation was supported by the work of Kumar *et al.* (2016), and Mishra *et al.* (2019) observed proper growth and development of plant was observed in conventional tillage plots.

The maximum mean number of primary branches per plant was found in Polythene mulch (4.91) whereas the minimum was found in no mulch (4.43 cm). This might be due to the better suppression of weed growth resulting in less competition and reduced loss of nutrients from the soil as compared to other treatments. The mulch help in weed suppression, increases soil fertility, maintains soil temperature and reduces leaching losses. This observation was supported by the work of Yadav (2006) and Anand *et al.* (2020).

Maximum primary branches per plant were recorded in a combination of Conventional tillage + Rice straw mulch (5.53). Minimum primary branches per plant were recorded in a combination of (L2M1) which received in Minimum tillage + Polythene mulch (3.53) at harvest.

Maximum number of siliquae per plant was observed in conventional tillage (L1) 185 and the minimum number of siliquae per plant was observed in minimum tillage (L2) 170.

Several siliquae per plant under polythene mulch (M3) were significantly higher than in other mulch treatments. Several siliquae per plant under Tree leaves mulch (M4) and No mulch (M1) was found to be statistically at par with rice straw mulch (M2) and tree leaves mulch (M4) was found to be statistically at par with No mulch (M1). A maximum number of siliquae per plant was observed in polythene mulch (M3) 189 and a minimum number of siliquae per plant was observed in No mulch (M1) 169. This might be due to the lesser weed competition for nutrients, moisture, space and sunlight at flowering and siliquae development stages which reduced the abscission of flowers and siliquae by mulching. This observation was supported by the work of Yadav (2006) and Anand *et al*. (2020). A maximum number of siliquae per plant was recorded in a combination of (L1M3) with 197 which was received in Conventional tillage + Polythene mulch and a minimum number of siliquae per plant was recorded in a combination of (L2M2) with 164 which received in Minimum tillage + Rice straw mulch.

Table 1. showed that tillage practices had a significant effect on the seed yield of mustard. The maximum seed yield per hectare was observed in conventional tillage (1629 kg/ha) and the minimum seed yield per hectare was observed in minimum tillage (1559 kg/ha). Conventional tillage (L1) plot showed the maximum seed yield as compared to Minimum tillage (L2) plots in which effective tillage activities like ploughing and harrowing were done to prepare fine seed bed hence there was good growth and development of plants with effective root system which helped in obtaining good seed yield of the crop. This observation was supported by the work of Ishaq *et al.* (2001), Kumar *et al.* (2016), Mishra *et al.* (2019), Liu *et al.* (2020)

Seed yield per hectare under polythene mulch (M3) was significantly higher than Tree leaves mulch (M4) and No mulch (M1) but seed yield per hectare under rice straw mulch (M2) was found to be at par with that of polythene mulch (M3). Seed yield per hectare under no mulch (M1) was found to be statistically at par with that of tree leaves mulch (M4). Maximum seed yield per hectare was observed in polythene mulch (1730 kg/ha) and minimum seed yield per hectare was observed in no mulch (1445 kg/ha). Maximum seed yield was recorded in a combination of (L1M3) 1790 kg/ha which was received in Conventional tillage + Polythene mulch and minimum seed yield was recorded in a combination of (L2M1) 1441 kg/ha which was received in Minimum tillage + No mulch. This might be due to the efficient utilization of resources like water, and nutrients and a better suppression of weed growth by mulching. Moreover, mulching helps to maintain proper soil temperature and its properties which enhance the growth of beneficial microbes in soil cumulatively resulting in higher yield. This observation was supported by the work of Yadav (2006), Anand *et al*. (2020) and Kader *et al*. (2019).

Data in Table 1 also showed that tillage practices had a significant effect on the stover yield of mustard. The maximum stover yield observed in Conventional tillage (L1) 4663 kg/ha was found to be significantly higher than that of Minimum tillage (4552 kg/ha).

Stover yield per hectare under Polythene mulch (M3) was significantly higher than Rice straw mulch (M2), Tree leaves mulch (M4) and No mulch (M1). Stover yield per hectare under Rice straw mulch (M2) was significantly higher than No mulch (M1). But stover yield per hectare under Tree leaves mulch (M4) was found to be statistically at par with that of Rice straw mulch (M2). Stover yield per hectare under Tree leaves mulch (M4) was significantly higher than No mulch (M1). Maximum stover yield per hectare was observed in Polythene mulch (M3) 4730 kg/ha and the minimum from No mulch (M1) 4453 kg/ha.

Maximum stover yield per hectare was recorded in a combination of (L1M3) 4790 kg/ha which was received in Conventional tillage + Polythene mulch whereas the minimum was recorded from the combination of (L2M1) 4441 kg/ha which was received in Minimum tillage + No mulch. Moreover, mulching helps to maintain proper soil temperature and its properties which enhance the growth of beneficial microbes in soil cumulatively resulting in higher yield. This observation was supported by the work of Yadav (2006) and Anand *et al*. (2020).

The maximum harvest index (%) observed in Conventional tillage (L1) 25.88% were found to be significantly higher than the Minimum tillage (L2) 25.49%. The harvest index under Rice straw mulch (M2) was significantly higher than Tree leaves mulch (M4) and No mulch (M1). But the harvest index (%) obtained under Polythene mulch (M3) was found to be statistically at par with that of Rice straw mulch (M2). The maximum harvest index was observed in Rice straw mulch (M2) at 26.88% and the minimum harvest index was observed in Tree leaves mulch (M4) at 24.45%. This may be due to the better allocation of photosynthates from source to sink by mulching Yadav (2006). Maximum harvest index was recorded in a combination of (L1M2) 27.50% which was received in Conventional tillage +Rice straw mulch and minimum harvest index was recorded in a combination of (L1M4) 24.13% which was received in Conventional tillage + Tree leaves to mulch.

Data in Table 1 showed that tillage practices had a significant effect on the oil yield of Indian mustard. The maximum oil yield (kg/ha) recorded in Conventional tillage (L1) 621 kg/ha was significantly higher than Minimum tillage (L2) 588 kg/ha. This observation was supported by the work of Mishra *et al.* (2019). Oil yield under Polythene mulch (M3) was significantly higher than Tree leaves mulch (M4) and No mulch (M1). But the oil yield obtained under Rice straw mulch (M2) was found to be statistically at par with that of Polythene mulch (M3). Oil yield under Rice straw mulch (M2) was significantly higher than Tree leaves mulch (M4) and No mulch (M1). Maximum oil yield was observed in Polythene mulch (M3) 666 kg/ha and minimum in No mulch (M1) 553 kg/ha. Maximum oil yield was recorded in a combination of (L1M3) 692 kg/ha which was received in Conventional tillage + Polythene mulch and minimum harvest index was recorded in a combination of (L2M4) 548 kg/ha which was received in Minimum tillage + Tree leaves to mulch.

Table 1. Growth and yield of rainfed Indian mustard under different tillage practices and mulching

Treatment	Plant height (cm)	Branches/plant	No. of siliqua / plant	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index	Oil yield (kg/ha)
Tillage								
Conventional Tillage (L_1)	151.17	5.29	185	4.69	1629	4663	25.88	621
Minimum Tillage (L_2)	137.25	4.08	170	4.45	1559	4552	25.49	588
S.Em(±)	2.23	0.12	2.38	0.03	11.47	14.82	0.03	4.44
C.D.(p=0.05)	13.62	0.78	14.50	0.19	69.79	90.20	0.18	27.02
Mulching								
No mulch (M_1)	136.17	4.43	169	4.55	1455	4453	24.63	553
Rice straw mulch (M_2)	145.33	4.76	179	4.52	1706	4643	26.88	646
Polythene mulch (M_3)	157.50	4.91	189	4.67	1730	4730	26.78	666
Tree leave mulch (M_4)	137.83	4.63	171	4.55	1484	4604	24.45	554
S.Em(±)	3.00	0.10	3.12	0.16	12.36	20.66	0.20	8.15
C.D.(p=0.05)	9.24	0.32	9.63	NS	36.15	63.67	0.62	25.12
Interaction (Lx M)								
S.Em(±)	4.24	0.14	4.42	0.23	17.51	29.22	0.28	11.53
C.D.(p=0.05)	13.07	0.46	13.61	NS	53.96	90.05	0.87	35.53

Table 2. Economics and Energy of rainfed Indian mustard under different tillage practices and mulching

Treatment	B:C ratio	Energy use efficiency	Energy productivity (kg/MJ)	Specific energy (MJ/kg)
L_1M_1	0.54	4.68	0.30	03.32
L_1M_2	0.71	1.26	0.07	12.64
L_1M_3	0.03	3.07	0.19	05.16
L_1M_4	0.57	1.10	0.07	14.10
L_2M_1	0.63	4.88	0.31	03.18
L_2M_2	0.72	1.20	0.07	13.11
L_2M_3	0.10	5.03	0.19	05.20
L_2M_4	0.66	1.09	0.07	14.22

*L_1 – Conventional Tillage ; L_2 – Minimum Tillage
*M_1 – No mulch ; M_2 – Rice straw mulch ; M_3 – Polythene mulch M_4 – Tree leave mulch

The highest benefit-cost ratio (0.72) was recorded in Minimum tillage + Rice straw mulch because there was less input cost for tillage or ploughing activities and mulching material cost. Hence the minimum cost of cultivation resulted in the highest B: C ratio. By adopting Minimum tillage with Rice straw mulch maximum benefits can be achieved. This might be due to the minimum cost of cultivation to produce high-crop produce. Such variations in economics among different treatments in tillage and mulching were also reported by Mondal *et al*. (2008), Jain and Jha (2012), Kumar *et al.* (2015) and Mounika *et al.* (2020).

Energy use efficiency

Among the different treatments, the highest energy use efficiency (4.88) was recorded in treatment L2M1 which was received in Minimum tillage + No mulch and the lowest energy use efficiency (1.09) was recorded in treatment L2M4 which was received in Minimum tillage + Tree leaves to mulch.

Energy productivity (kg/MJ)

Among the different treatments the highest energy productivity (0.31 kg/MJ) was recorded in treatment L2M1 which was received in Minimum tillage + No mulch and the lowest energy productivity (0.07 kg/MJ) was recorded in treatment L2M4 which was received in Minimum tillage + Tree leaves to mulch.

Specific energy (MJ/kg)

Among the different treatments, the lowest specific energy (3.18 MJ/kg) was recorded in treatment L2M1 which was received in Minimum tillage + No mulch and the highest specific energy (14.22 MJ/kg) was recorded in treatment L2M4 which was received in Minimum tillage + Tree leaves to mulch.

The highest energy use efficiency, and energy productivity but lowest specific energy was observed in Minimum tillage with No mulch and energy use efficiency, and energy productivity but highest specific energy was observed in Minimum tillage with Rice straw mulch. This was due to the use of less amount of energy input to produce more amount of energy output. Such variations in energy among different treatments in tillage and mulching were also reported by Singh *et al.* (2018) and Choudhary *et al.* (2017).

CONCLUSION

From the economic point of view, the highest monetary benefits in terms of maximum B: C ratio can be obtained from the combination of Minimum tillage + Rice straw mulch. The highest energy use efficiency and lowest specific energy were found in the treatment combination of Minimum tillage +No mulch.

ACKNOWLEDGEMENT

The authors are thankful to the Dean College of Agriculture, Central Agricultural University, Imphal, India for providing all the facilities necessary to carry out this experiment.

REFERENCES

Anand, D.D., Singh, M.S., Lhungdim, J., Devi, N.S. and Singh, N.G. 2020. Effect of mulching on growth and yield of soybean (Glycine max (L.) Merrill).

Int. J. Curr. Microbiol. App. Sci., 9(9): 3313-3318.

Busari, M.A., Kukal, S.S., Kaur, A., Bhatt, R. and Dulazi, A.A. 2015. Conservation tillage impacts on soil, crop and the environment. *Int. Soil Water Conserv. Res.,* 3(2): 119-129.

Chinnathurai, S.J., Veeramani, A. and Prema, P. 2012. Weed dynamics, yield and economics of pigeonpea influenced by growth promoters and mulching. *Indian j. Weed sci.,* 44(3): 186-190.

Choudhary, M., Rana, K.S., Bana, R.S., Ghasal, P.C., Choudhary, G.L., Jakhar, P. and Verma, R.K. 2017. Energy budgeting and carbon footprint of pearl millet - mustard cropping system under conventional and conservation agriculture in rainfed semi-arid agro-ecosystem. *Energy,* 141: 1052-1058.

Ishaq, M., Ibrahim, M. and Lal, R. 2001. Tillage effect on nutrient uptake by wheat and cotton as influenced by fertilizer rate. *Soil Tillage Res*., 62(2): 45-53.

Jain, S. and Jha, A. K. 2012. Effect of different tillage systems on yield and economics of mustard varieties and soil properties for Kymore Plateau and Satpura Hill Zone of Madhya Pradesh. *Res. Crop.,* 13: 134-138.

Kader, M.A., Senge, M., Mojid, M.A. and Ito, K. 2017. Recent advances in mulching materials and methods for modifying soil environment. *Soil Tillage Res.,* 168: 155 – 166.

Kumar, A. 2012. Production barriers and technological options for sustainable production of rapeseed-mustard in India. *J. Oilseeds Res.,* 3(2): 67-77.

Kumar, R., Singh, R.S., Singh, D. and Kumar, S. 2016. Effect of tillage and irrigation levels on growth and yield of Indian mustard (*Brassica juncea* L.). *Environ. Ecol.*, 34: 2345-2348.

Liu, J., Fan, Y., Ma, Y. and Li, Q. 2020. Response of photosynthetic active radiation interception, dry matter accumulation and grain yield to tillage in two winter wheat genotypes. *Arch. Acker Pflanzenbau Bodenkd*., 66(8): 1103-1114.

Mishra, J., Singh, R.K., Yadaw, D., Das, A. and Sahoo, S. 2019. Effect of tillage and irrigation frequency on growth of Indian mustard [*Brassica juncea (L.) Czernj and Cosson*]. *Int. J. Chem. Stud.,* 7(1): 2127-2130.

Mondal, N.A., Hossain, S.M.A., Bhuiya, S.U. and Jahiruddin, M. (2008). Productivity of rainfed mustard in relation to tillage and mulching. *Bangladesh J. Agril. Res.,* 33: 4.

Mounika, K.P.E., Lhungdim, J., Athokpam, H.S. and Singh, N.O. 2020. Resource conservation technology in pigeonpea (*Cajanus cajan (L.) Mill sp*.) through tillage and mulching. *Int.J.Curr.Microbiol.App.Sci.,* 9(9): 3246-3251.

Singh, R., Babu, S., Avasthe, R., Yadav, S.G., Chettri, T.K. and Singh, A. 2018. Effect of organic mulches and vermicompost on productivity, profitability and energetic of mustard (*Brassica campestris*) in popcorn (*Zea mays everta*)-mustard cropping system in rainfed Sikkim Himalaya. *Indian J. Agric. Sci.,* 88(11): 1735-1739.

Subrahmaniyan, K., Kalaiselvan, P. and Arulmozhi, N. 2002. Weed control in groundnut (Arachis hypogaea L.) with polyethylene film mulching. *Int. J. of Pest Manag*., 48(3): 261-264.

Ved, S. 2000. Effect of tillage practices and irrigation levels on growth and yield of American cotton grown after wheat. *Indian J. Agric. Sci*., 70(8): 538-540.

Yadav, R.D., Pareek, R.G. and Yadav, R.L. 2006. Effect of mulching and sulphur on growth and yield of mustard, *Brassica juncea (L.) Czem & Cosson* under varying levels of irrigation. *J. Oilseed Res*., 23 (2): 219-221.

Citation: Devi, K. Nandini; Naidu Bhargavi Naga Kalyani; J. Lhungdim; A. Herojit; N. Gopimohan, KSH. Manishwari Devi and A. Dorendro 2022. Response of rainfed Indian mustard to different tillage practices and mulching. *International Journal of Agricultural and Applied Sciences*, 3(2): 60-64. https://doi.org/10.52804/ijaas2022.3211