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Influence of tillage practices and nutrients sources on growth parameters and their correlation with yield of mustard

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Abstract

An experiment was conducted to study the effect of tillage practices and different nutrient sources on growth, growth indices and yield of mustard. The experiment was directed in split plot design comprising of three main plots [(Zero tillage, Reduced tillage and conventional tillage) and four sub plots (75% RDN, 100% RDN, 75% RDF and 100% RDF) treatments]. Results revealed that plant height (137.92 cm), dry matter accumulation (393.03 g/m^2), absolute growth rate (0.20 g/day), crop growth rate (0.83 g/m^2/day), dry matter efficiency (0.149 %), unit area efficiency (0.00062 kg/ m^2/day), seed yield (1045.0 kg/ha) and straw yield (3242.3 kg/ha) of mustard were highest under reduced tillage. Among different nutrient sources, 100 per cent recommended dose of fertilizer recorded highest plant height (139.72 cm), dry matter accumulation (407.81 g/m^2), dry matter efficiency (0.151 %), unit area efficiency (0.00065 kg/ m^2/day), seed yield (1098.4 kg/ha) and straw yield (3112.6 kg/ha) whereas absolute growth rate (0.17 g/day) and crop growth rate (0.77 g/m^2/day) were highest with 75 per cent recommended dose of fertilizer. Correlation studies showed that plant height, dry matter accumulation, absolute growth rate, dry matter efficiency and unit area efficiency had positive significant association with mustard yield, indicating the importance of these traits in selection for yield. It was concluded that among tillage practices, reduced tillage proved best for growth and productivity of mustard whereas in case of different nutrient sources, 100 per cent recommended dose of fertilizer was found better.

Key words: Conventional tillage, Farm yard manure, Growth, Mustard, Reduced tillage, Yield, Zero tillage

India is the largest producer of oilseeds in world. Oilseed crops are the second most important determinant of agricultural economy, next only to cereals within the segment of field crops. Mustard (*Brassica carinata* L.) is an important *rabi* oilseed crop which contributes 27 per cent of total oilseeds production. In Himachal Pradesh, it is grown over an area of 8.61 thousand hectares with production of 4.90 thousand tonnes and productivity of 570 kilogram per hectare (Anonymous 2019). Its seed contains 37 to 49 percent oil. The mustard oil is used for domestic purposes while the oil cake is used as cattle feed and manure (Singh *et al*. 2014). India has also diverse agro-ecological areas for their growth. The cultivation of oil crops, in general, is not labor intensive and thus these crops can be managed in labor scarce areas. Its cultivation is very economical and remunerative, which helps in improving the socio-economic status of the farmers. That is why, oil crops are an ideal component in the sustainable production system in Indian agriculture.

Karan rai yields well and shows better environment adoption and substantial resistance to pests and diseases (Sekhawat *et al*. 2012).The conventional tillage methods have been used to grow many crops including mustard but they are expensive operations in terms of work and fuel consumption. It also leads to high erosion hazards because it completely inverts the soil and buries all the crop residues. The alternate for all these problems is conservation tillage. Tillage systems such as zero tillage and minimum or reduced tillage leave more

crop residues and offer greater erosion control. Fuel and labour requirements are also reduced significantly with conservation tillage. Zero tillage is one of the most used resource conservation technique which not only promotes input-use efficiency but also strengthens natural resource base. Similarly, reduced tillage is said to be one of the potential ways to reverse land degradation and ultimately increase the productivity. The researchers and farmers are looking to adopt alternative tillage methods due to environmental concern and cost involved. Soil moisture is the major limiting factor for crop production under *rainfed* situation, therefore, moisture conservation is very important to achieve higher yield. The effect of mulch on soil temperature, moisture regime and root growth as well as yield depends on the climatic conditions, quality and quantity of mulch materials. Further, mulching reduces evaporation, weed population and there by enhance infiltration rate (Katiyar, 2001). Conservation tillage uses 10.2 per cent less water than conventional tillage and increases water use efficiency by 35.8 per cent (Saroch *et al*. 2012) Besides appropriate selection of tillage practices, use of inorganic and organic sources of nutrients have potential in correcting the decline trend in soil-health and productivity through the correction of marginal deficiencies of some secondary and micro-nutrients, micro-flora and fauna and their beneficial influence on physical and biological properties of soil (Chondie, 2015). In this context, use of chemical fertilizer and organic manure like Farm yard manure (FYM) and crop residue assumes greater significance. Considering the above said facts, an experiment was conducted to study the effect of different tillage practices, organic and inorganic sources of nutrients on growth and productivity of mustard.

Materials and Methods

Experimental details

The field experiment was conducted for two rabi consecutive seasons in 2019-20 and 2020-21 at Agronomy Research Farm, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. In the first *rabi* season of 2019-20, the weekly minimum and maximum temperature ranged from 1.6 to 14.6 $^{\circ}$C and 13.1 to 26.2 $^{\circ}$C, respectively. The total sunshine hours received during first cropping season were 158.4 hours. Relative humidity ranged from 52.1 to 80.65 per cent. Total rainfall received during the experimental period of mustard was 700.6 mm. In the next *rabi* season (November 12th, 2020 to May 13th, 2021), the weekly minimum and maximum temperature ranged from 0.8 to 15.7 $^{\circ}$C and 15.2 to 28.9 $^{\circ}$C respectively. The total sunshine hours received were 178 hours. Relative humidity ranged from 39.7 to 71.25 percent. Total rainfall received was 381.8 mm during soybean.

Experiment was laid out in split plot design with three replications. There were three main-plots, combinations of three tillage practices (zero tillage, reduced tillage and conventional tillage) and four sub plots treatments (75 % and 100 % recommended dose of nitrogen, 75 % and 100 % recommended dose of fertilizers). 75 % and 100 % recommended dose of nitrogen was applied through FYM.

Zero tillage (ZT)	Direct sowing behind the country plough
Reduced tillage (RT)	Sowing behind the country plough after one ploughing by power tiller + surface retention of soybean residue @ 3t/ha after sowing
Conventional tillage (CT)	Sowing behind the country plough after two ploughing by power tiller

'Jayanti' was used as test variety sown at 30 cm (row spacing) on 14th November 2019 and 12th November 2020, respectively. Paraquat @ 0.6 l/ha plus 750 l of water was sprayed a week before sowing of the crop. Bavistin @ 2.5 g/kg was used to treat the seed before sowing for the protection of crop plants from seed borne diseases. Farmyard manure (FYM) was applied as per treatment at the time of sowing. Recommended dose of fertilizers (60:40:40) was applied @ 75 and 100 % at the time of sowing. The N, P and K nutrients were applied through urea, SSP and muriate of potash, respectively. Soybean straw @ 3t/ha was used as mulch material in reduced tillage plots. For control of weeds, pendimethalin @1.5 kg/ha plus 750 l of water was sprayed just after sowing of the crop. In addition, one hand weeding was also done at 6 weeks after sowing.

Data collection and statistical analysis

Data was recorded on, plant height (cm), dry matter accumulation / m^2 and yield (kg/ha) of mustard. Growth indices such as absolute growth rate (Radford, 1967), crop growth rate (Watson, 1956), dry matter efficiency and unit area efficiency were calculated on the basis of plant height, dry matter accumulation and yield. After harvesting, seed yield was recorded on net plot basis and then converted into kilogram per hectare. The data generated from field were subjected to analysis of variance with mean comparison of 5% level of significance (Gomez and Gomez, 1984). Pooled analysis of the data had been done.

Results and Discussion

During both the years, different growth parameters such as plant height and dry matter accumulation per metre square were significantly affected by tillage practices and nutrient sources (Table 1). Reduced tillage recorded significantly taller plants along with higher dry matter accumulation per metre square which was at par with conventional tillage. This might be due to crop residue retention which changed the soil ecology, affecting the microbial population and activity in the soil, as well as nutrient transformation. Increased organic matter content in reduced tillage plots improves the soil structure and thus rooting zone which ultimately enhanced the plant height and dry matter accumulation. Singh *et al*. (2014) showed considerably taller plants in reduced tillage techniques. Another reason might be better distribution of water and nutrients in the soil profile and the use of such nutrients by diverse soil organism results in a greater cycling of the available nutrients. Several studies (Corbeels *et al*. 2014, Das *et al*. 2014, Farooq and Siddique, 2015) have also supported these findings. Zero tillage plots recorded significantly shorter plants and dry matter accumulation of mustard. Better performance under conventional tillage than zero tillage was due to mineralization of nutrients due to mechanical mixing of soil. Similar results were found by (Gangwar *et al*. 2004 and Singh, 2006) who reported that conventional tillage practices increased the availability of soil nitrogen, phosphorus and potash than that of the zero tillage. The shortest plants and lowest dry matter production under zero tillage practices was might be due to soil compaction which leads to inhibition in root growth, reduction in root density and nutrients absorption efficiency at greater depths. The outcomes were comparable to Martnez *et al*. (2008) who found higher root masses under conventional tillage than zero tillage. Among nutrient sources, 100 per cent recommended dose of fertilizer recorded significantly higher plant height and dry matter accumulation of mustard which was at par with 75 per cent recommended dose of fertilizer. This might be due to high nutrient requirement of mustard, thus it responded well to inorganic fertilizers

Table 1. Effect of tillage practices, organic and inorganic sources of nutrients on growth parameters of mustard

	Plant height (cm)			Dry matter accumulation (g/m^2)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Tillage practices						
ZT	127.09	110.18	118.64	388.1	269.2	328.63
RT	146.49	129.34	137.92	451.2	334.9	393.03
CT	140.26	124.53	132.39	426.7	312.1	369.39
SEm ±	3.12	3.03	1.99	9.5	7.5	6.61
LSD(P=0.05)	12.26	11.88	7.80	37.3	29.3	25.94
Nutrient Sources						
75 % RDN (FYM)	128.24	106.47	117.36	372.6	259.2	315.88
100% RDN(FYM)	132.44	116.38	124.41	391.7	282.5	337.09
75 % RDF (Inorganic)	144.63	129.58	137.10	458.7	329.2	393.94
100 % RDF(Inorganic)	146.47	132.98	139.72	465.0	350.7	407.81
SEm ±	3.71	3.45	2.20	13.4	9.8	7.95
LSD (P= 0.05)	11.03	10.24	6.53	40.0	29.2	23.62

ZT : Zero Tillage RT : Reduced Tillage CT: Conventional Tillage RDN: Recommended dose of nitrogen, RDF : Recommended dose of fertilizers

in which nutrients are readily available.However,75 per cent recommended dose of nitrogen through FYM recorded significantly shorter plants as well as low dry matter accumulation (Table 1).

Absolute growth rate and crop growth rate showed significance difference with respect to tillage practices and nutrient sources (Table 2). Highest absolute growth rate and crop growth rate was found with reduced tillage. It was because of taller plants and highest dry matter accumulation in respective tillage practices. In terms of different nutrient sources, 75 per cent recommended dose of fertilizer recorded highest absolute growth rate and crop growth rate. Resultant dry matter efficiency did not show any significant difference whereas unit area efficiency was significantly affected (Table 2). Significantly higher unit area efficiency was recorded in reduced tillage plots where mulch was applied followed by conventional tillage. Among nutrient sources, highest unit area efficiency was recorded with 100 per cent recommended dose of fertilizer.

Seed yield and straw yield of mustard was significantly affected by different tillage practices and nutrient sources (Table 3). Reduced tillage practices

Table 2. Effect of tillage practices, organic and inorganic sources on growth indices of mustard

	Absolute growth rate (g/day)			Crop growth rate (g/m^2/day)			Dry matter efficiency (%)			Unit area efficiency (kg/m^2/day)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Tillage practices												
ZT	0.12	0.06	0.09	0.35	0.61	0.48	0.147	0.148	0.147	0.00057	0.00049	0.00053
RT	0.21	0.18	0.20	1.00	0.66	0.83	0.149	0.149	0.149	0.00068	0.00056	0.00062
CT	0.13	0.11	0.12	0.89	0.50	0.70	0.148	0.147	0.148	0.00064	0.00053	0.00059
SEm ±	0.01	0.005	0.004	0.01	0.01	0.004	0.004	0.003	0.002	0.00001	0.00001	0.00001
LSD(P=0.05)	0.03	0.02	0.014	0.04	0.04	0.02	NS	NS	NS	0.00006	0.00004	0.00003
Nutrient Sources												
75 % RDN (FYM)	0.14	-0.05	0.05	0.96	0.37	0.66	0.148	0.146	0.147	0.00056	0.00045	0.00050
100% RDN(FYM)	0.16	0.19	0.17	0.10	0.34	0.22	0.147	0.145	0.146	0.00059	0.00048	0.00054
75 % RDF(Inorganic)	0.21	0.13	0.17	1.33	0.75	1.04	0.149	0.151	0.150	0.00067	0.00057	0.00062
100 % RDF(Inorganic)	0.10	0.19	0.15	0.62	0.92	0.77	0.149	0.151	0.150	0.00070	0.00060	0.00065
SEm ±	0.01	0.005	0.004	0.03	0.02	0.020	0.007	0.004	0.004	0.00002	0.00002	0.00001
LSD (P= 0.05)	0.03	0.01	0.011	0.09	0.05	0.06	NS	NS	NS	0.00006	0.00005	0.00004

ZT : Zero Tillage RT : Reduced Tillage CT: Conventional Tillage RDN: Recommended dose of nitrogen RDF : Recommended dose of fertilizers

Table 3. Effect of tillage practices, organic and inorganic sources of nutrients on yield of mustard

	Seed yield (kg/ha)			Straw yield (kg/ha)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Tillage practices						
ZT	966.0	825.4	895.7	2950.9	2464.6	2707.8
RT	1134.6	955.4	1045.0	3415.2	2810.1	3112.6
CT	1072.0	907.8	989.9	3240.4	2708.9	2974.7
SEm ±	24.4	17.4	14.7	73.3	61.8	36.9
LSD(P=0.05)	95.7	68.1	57.9	287.7	242.6	144.7
Nutrient Sources						
75 % RDN (FYM)	939.4	761	850.0	2842.1	2318.7	2580.4
100% RDN(FYM)	989.4	824	906.8	3053.6	2521.1	2787.4
75 % RDF (Inorganic)	1130.3	974	1052.2	3408.8	2824.7	3116.7
100 % RDF (Inorganic)	1171.0	1026	1098.4	3504.2	2980.3	3242.3
SEm ±	36.0	30.5	25.1	113.5	80.6	65.2
LSD (P= 0.05)	107.0	90.6	74.5	337.2	239.3	193.6

ZT: Zero Tillage RT: Reduced Tillage CT: Conventional Tillage RDN: Recommended dose of nitrogen RDF: Recommended dose of fertilizers

recorded significantly higher yield which was at par with conventional tillage practices. Better performance under reduced tillage was due to crop residues retention over the surface. Nutrients drawn from residues of the previous crop enable better nutrients cycling and also increases the availability of nutrients near the soil surface where crop root proliferates. Retained residues in reduced tillage treatments, on the other hand, boosted and prolonged soil moisture conservation, favored improved development with higher photosynthetic efficiency, resulting in improved yield attributes and higher crop yields. Similar reports were also made by Derpsch and Friedrich (2010) and Faiz *et al*. (2022). Lowest seed yield was recorded in the plots where zero tillage practices were adopted. It might be due to incredibly compact soil base and poor soil drainage. Yield was significantly affected by organic and inorganic nutrient sources. Among different nutrient sources, significantly higher seed and straw yield was recorded with 100 per cent recommended dose of fertilizer which was at par with 75 per cent recommended dose of fertilizer. This was due to availability of required nutrients to the crop through fertilizer application as per need. 75 per cent recommended dose of nitrogen provided through farm yard manure, recorded significantly lower yield of mustard during both the years. This might be due to the reason that nutrients provided through fertilizers are readily available to the plant, which increased vegetative growth and yield abruptly contrary to other treatments where nutrients are released slowly. The earlier research workers namely Bambal *et al*. (1998) also reported direct contribution of inorganic nutrient sources on yield performance of crop.

Table 4 represents the correlations between the mustard growth parameters and yield. It appeared that some parameters were either positively correlated to others while some were non-significant. Yield of mustard was significantly and positively correlated with plant height, dry matter accumulation, absolute growth rate, dry matter efficiency and unit area efficiency. This implies that value increase of one of this parameter leads to the increase of the parameter to which it is significantly correlated. Crop growth rate showed no significant correlation with seed yield. Results were in similarity with Kasu -Bandi *et al.* (2019) which reported positive correlation between growth and yield parameters.

This study had shown that adoption of reduced tillage practices along with mulch material not only increased the growth and productivity of mustard but also provided the good health to the soil. 100 per cent recommended dose of fertilizer was better for growth and yield of mustard but economically, 75 per cent recommended dose of fertilizer can be adopted to gain better yield of mustard at minimal cost.

Conflict of interest: The authors declare that there is no conflict of interest in this research paper.

Table 4. Correlation matrix between growth parameters and yield of mustard

Mustard parameters	Plant height	Dry matter accumulation	Absolute growth rate	Crop growth rate	Dry matter efficiency	Unit area efficiency
Dry matter accumulation	0.812**					
Absolute growth rate	0.501**	0.415*				
Crop growth rate	0.344*	0.443**	-0.149			
Dry matter efficiency	0.226	0.221	0.089	0.004		
Unit area efficiency	0.781**	0.731**	0.419*	0.254	0.526**	
Seed Yield	0.789**	0.737**	0.419*	0.259	0.519**	0.999**

**Significant at $p \leq 0.01$

*Significant at $p \leq 0.05$

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