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Effect of land configuration methods and sulphur levels on growth, yield and economics of Indian mustard [*Brassica juncea* (L.)] under irrigated condition

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Abstract

A field experiment was conducted at Varanasi, during *rabi* season of 2015-16, to study the effect of land configuration and sulphur levels on yield attribute, yield and economics of Indian mustard [*Brassica juncea* (L.)] on a sandy clay loam soil at Agriculture research farm, Institute of Agricultural Sciences, BHU, Varanasi, UP, India. The investigation was carried out in a spilt plot design with 3 replications. The treatment comprised of four land configuration methods(-M_1 - Flat bed broadcasting - M_2 - Furrow sowing M_3 - Flat line sowing and M_4 - Ridge side sowing) as main plot factor and four sulphur levels (control, 20 kg S ha^{-1}, 30 kg S ha^{-1} , 40 kg S ha^{-1}) as sub plot factor. Furrow sowing was significantly superior over other land configuration methods in terms of growth parameter, yield attributes and yield as well as economics of crop cultivation. The different levels of sulphur showed a positive response on influencing the growth attributes, yield attributes and yield of mustard. The application of 40 kg S ha^{-1} was significant over other sulphur levels in terms of growth parameters, yield attributes and yield and profitability of mustard crop cultivation.

***Key Words**: Economics, growth and yield, land configuration, Indian mustard, sulphur levels*

Introduction

Rapeseed-mustard is the most important edible oilseed crop after groundnut and soybean. Indian mustard occupies more than 70 % of the area under Rapeseed-mustard group of crops grown in India (1). It is a winter (*Rabi*) season crop that requires relatively cool temperature, a fair supply of soil moisture during the growing season and a dry harvest period (Banerjee *et al.*, 2010) grown widely in 13 states of India including Rajasthan, Gujarat, Haryana, M.P., Uttarakhand, Uttar Pradesh, Bihar, West Bengal and Assam. India occupies third position in rapeseed-mustard production in the world after China and Canada. It plays an important role in the oilseed economy of the country. The estimated area, production and productivity of rapeseed-mustard in the world were 34.19 mha, 63.09 mt and 1,850 kg ha^{-1} (Anonymous, 2016). In world, India account 19.29 % of the total acreage and 10.07 % of production of rapeseed and mustard (FAO statistics, 2015). In India, during 2014-15 the mustard crop had production of about 6.31 mt from an area of 6.51mha with an average productivity of 1089 kg ha^{-1}. Due to poor yield, oil seed production in the country does not meet the requirement of growing population. Yield obtained from mustard is low due to adoption of poor agronomic practices, of which nutrient management and planting methods are most important (Om *et al*., 2013).

Land configuration methods including the alteration of shape of seed bed and land surface among the various methods the broad bed and furrow sowing, Furrow sowing, tied ridge sowing, ridge with mulches, on ridge, alternate furrow sowing, ridge sowing are adopted by the crop grower for rapeseed and mustard and other crops for obtaining the better yield over the flat bed or conventional method of sowing. Better conditions for Plant growth are provided in-furrow planting due to higher soil moisture, higher salt leaching and reduction in evaporation from the soil surface (Zhang *et al*., 2007; Li *et al*., 2010).

Various nutrients and micronutrients are required for oilseed production, but the nutrient which plays a multiple role in providing nutrition to oilseed crops, particularly table hose belonging to cruciferae (brassicacae) family is sulphur (Yadav *et al*., 2010). Mustard is responsive to sulphur in comparison to other crops. Sulphur is essential for the growth and development of all crops. Oleiferous *Brassica* crops in general have high sulphur requirement owing to higher seed and oil yield (Aulakh *et al.,* 1980; Singh and Shahu, 1986). The present study was therefore, undertaken to evaluate the effects of land configuration methods and sulphur levels on growth and yield of Indian mustard, and asses economics of crop cultivation under irrigated condition having sandy loam texture alluvial soil of eastern Uttar Pradesh.

Materials and Methods

The experiment was carried out at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (25°18'N and 83°03'E) during *rabi* 2015-16. The soil was sandy clay loam texture having 7.30 ph, EC (dSm^{-1} at 25°C), 0.35% organic carbon, 190.50-19.30-210.15 kg ha^{-1} available N-P-K and 20.73 mg kg^{-1} of sulphur. The experiment was laid out in split-plot design with three replications, consisting of four methods of land configuration *viz*. M_1= Flatbed broadcasting, M_2=Furrow sowing, M_3=Flatbed line sowing, M_4= Ridge side sowing as main plot factor and four sulphur levels of *viz.* S_0= Control (0 kg ha^{-1}), S_1= 20 kg ha^{-1}, S_2= 30kg ha^{-1}, S_3= 40kg ha^{-1} as sub plot factor. Before sowing of trial maize bean was taken as *Kharif* crop in the field. Sowing of Indian mustard variety 'varuna' was done on 3rd December of 2015 by a help of spades and *kudali* with seed rate of 5.0 kg ha^{-1} at 5 cm depth and broadcasted as per treatment and was harvested on 26th March of 2016 during both the years, respectively. As per treatment fixed amount of was applied through bentonite sulphur (90 % S) 15 days before sowing, the other nutrient fertilizer applied as per recommendation for the crop in particular region under irrigated condition and well decomposed farmyard manure was applied 2–3 weeks before sowing and incorporated in the soil. Half dose of nitrogen and full dose of phosphorus and potash were applied as basal dressing and remaining dose of nitrogen as top dressing after 30 DAS and after first irrigation. Other cultural practices such as weeding, interculture, plant protection measures etc. were applied as per need. Data obtained from crop was statistically analyzed by using the F-test as per the procedure given by Gomez and Gomez (1984), CD at P=0.05 were used to determine the significance differences between treatment means.

Results and Discussion

Growth attributes

Variation in plant height, functional leaves $plant^{-1}$ and leaf area index due to land configuration methods observed at all stages of plant growth. At most of the stages significant variation was observed only except 30 DAS, the furrow sowing recorded highest plant height at all stages. Increasing levels of sulphur from 0 to 40 kg S ha^{-1} caused marked improvement in plant height at all the growth stages. 40 kg S ha^{-1} recorded the maximum plant height than other treatments at all growth stages. There are also observed decline in No. of green leaves $plant^{-1}$ sharply between 60 and 90 DAS. The furrow method of land configuration recorded the more leaf area index than other treatments at all growth stages up to 90 DAS and 40 kg S ha^{-1} recorded the highest LAI at different growth stages which is statistical significant, there was significant difference in number of branches $plant^{-1}$ was recorded with furrow sowing method of land configuration. Application of 40 kg S ha^{-1} though remained comparable recorded significantly higher number of branches $plant^{-1}$ at 60 and 90 DAS as well as harvest. With different methods of land configuration different quantity of dry matter accumulation are recorded and found that the furrow method of sowing have significantly higher accumulation showed than the other method of land configuration, and at 30,60, 90 DAS and at harvest application of 40 kg S ha^{-1} produced significantly higher dry matter $plant^{-1}$ than lower level. These results are in conformity with those reported by Kuotsu *et al*. (2014), Parihar *et al*. (2009), Khanpara *et al*. (1993) and Ali *et al.* (1996).

Yield attributes

Among the land configuration methods No. of siliquae $plant^{-1}$, length of siliqua, seeds $siliqua^{-1}$, 1000-

Table-1: Effect of land configuration methods and sulphur levels on growth of Indian mustard [*Brassica juncea* (L.)] under irrigated condition

	Plant height (cm)				Functional leaves plant^{-1}			LAI			Total branches plant^{-1}			Dry matter accumulation(g plant^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
Land configuration methods																	
M_1 - Flat bed broadcasting	14.68	140.40	158.54	158.54	6.293	28.01	10.51	0.472	2.456	0.834	6.97	15.53	18.46	0.81	15.61	30.76	46.35
M_2 - Furrow sowing	15.86	152.04	165.03	165.03	6.904	31.75	11.78	0.504	2.771	0.899	8.28	19.01	23.61	0.86	18.72	34.48	52.03
M_3 - Flat line sowing	14.73	142.42	159.92	159.92	6.409	29.23	10.81	0.470	2.466	0.848	6.90	15.90	19.44	0.83	16.49	31.68	46.97
M_4 - Ridge side sowing	14.75	144.69	160.46	160.46	6.492	30.32	10.94	0.474	2.481	0.859	7.24	16.81	20.71	0.84	16.86	32.46	47.74
SEm±	0.27	1.05	1.13	1.13	0.163	0.61	0.16	0.007	0.039	0.013	0.17	0.24	0.42	0.007	0.27	0.37	0.43
CD(P=0.05)	NS	3.63	3.92	3.92	NS	2.12	0.54	0.024	0.135	0.044	0.57	0.82	1.44	0.024	0.92	1.28	1.50
Sulphur levels (kg S ha^{-1})																	
S_0-0	14.10	138.63	154.50	154.50	5.75	26.05	10.31	0.467	2.425	0.821	5.64	15.30	17.94	0.82	15.06	29.15	45.30
S_1-20	14.80	142.80	158.60	158.60	6.34	27.90	10.79	0.476	2.526	0.839	6.98	16.24	19.70	0.83	15.93	31.55	47.24
S_2-30	15.02	146.93	162.77	162.77	6.74	30.91	10.90	0.485	2.576	0.870	7.85	17.36	21.37	0.84	17.38	33.28	49.33
S_3-40	16.11	151.20	168.07	168.07	7.27	34.46	12.04	0.492	2.647	0.910	8.91	18.34	23.21	0.86	19.31	35.40	51.23
SEm±	0.14	0.87	1.04	1.04	0.11	0.42	0.18	0.004	0.046	0.008	0.16	0.18	0.30	0.004	0.24	0.35	0.39
CD(P=0.05)	0.41	2.55	3.04	3.04	0.31	1.24	0.53	0.011	0.134	0.023	0.47	0.54	0.89	0.012	0.71	1.03	1.15

Table-2: Effect of land configuration methods and sulphur levels on yield of Indian mustard [*Brassica juncea* (L.)] under irrigated condition

Treatments	No. of Siliquae plant $^{-1}$	Siliqua length (cm)	Seeds siliqua^{-1}	1000-seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
Land configuration methods							
M_1 - Flat bed broadcasting	218.15	3.55	13.46	3.76	13.85	46.93	22.79
M_2 - Furrow sowing	224.60	4.35	14.83	4.27	19.00	63.26	23.08
M_3 - Flat line sowing	218.62	3.69	13.52	3.79	15.00	50.46	22.90
M_4 - Ridge side sowing	219.49	3.68	13.92	3.83	16.31	54.54	23.01
SEm±	1.30	0.08	0.13	0.11	0.17	0.50	0.08
CD(P=0.05)	4.48	0.27	0.44	NS	0.59	1.74	NS
Sulphur levels (kg S ha^{-1})							
S_0-0	215.81	3.01	12.44	3.50	13.44	45.52	22.79
S_1-20	218.57	3.70	13.48	3.82	14.81	49.67	22.96
S_2-30	221.37	3.97	14.19	3.91	16.97	56.82	22.97
S_3-40	225.11	4.58	15.62	4.42	18.94	63.17	23.05
SEm±	0.70	0.08	0.14	0.09	0.20	0.59	0.07
CD(P=0.05)	2.04	0.23	0.42	0.27	0.57	1.72	NS

seed weight (g) was recorded with the furrow sowing methods over other treatments. Application of different sulphur levels also influenced the siliquae production in mustard. It was noted that increase in sulphur levels from 0 to 40 kg S ha^{-1} correspondingly enhanced the number of siliqua plant^{-1} and the sulphur applied at 20, 30 and 40 kg sulphur ha^{-1} produced significantly higher siliquae plant^{-1} over control. Similarly, 40 kg S ha^{-1} also proved its distinct superiority over 20 and 30 kg S ha^{-1}. The furrow method of sowing observed superior than other methods and found statistically significant over other treatments. Application of different levels of sulphur influenced siliqua length of mustard and 20, 30 and 40 kg S ha^{-1} over control and 40 kg S ha^{-1} found significantly superior over 20 and 30 kg S ha^{-1}.Among the all applied methods of land configuration furrow sowing of mustard recorded the highest No. of seeds per siliqua over other methods of land configuration, effect of sulphur application was also noticed on the production of seeds siliqua^{-1}. Increasing levels of sulphur application from 0 to 40 kg S ha^{-1} correspondingly observed increased No. of seeds per siliqua 20, 30 and 40 kg S ha^{-1} over control further 40 kg S ha^{-1} found significantly superior over 20 and 30 kg S ha^{-1}. Data given in table:- 2 showed that different methods of land configuration differed markedly in respect of test weight of 1000 seeds. Test weight varied with land configuration methods, Among the land configuration methods furrow sowing method of mustard sowing recorded highest test weight of (4.27 g), followed by ridge side sowing (3.83 g), flat bed line sowing (3.79 g) and flat bed broadcasting(3.76). However, the difference failed to touch the level of significance. As regards the sulphur application, test weight of mustard improved markedly with increasing levels of sulphur application from 0 to 40 kg S ha^{-1}, the present study is in accordance with the finding of Parihar *et al*., (2010), Rathore *et al* (2010), Om *et al*., (2013), Chiroma *et al*.,(2006) Verma *et al*. (2012) and Ray *et al.* (2015).

Seed and stover yields

The data of table: 3 showed that there was significant difference in seed yield with various methods of land configuration. The furrow method of sowing recorded the significantly highest seed yield of mustard (19.00 q ha^{-1}) followed by ridge side sowing (16.31 q ha^{-1}), flat line sowing (15.00 q ha^{-1}), and flat bed broadcasting method of sowing (14.85 q ha^{-1}). It is also cleared from the data that

Table 3: Effect of land configuration methods and sulphur levels on economics of Indian mustard [*Brassica juncea* (L.)] under irrigated condition

Treatments	Gross return (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Land configuration methods				
M_1 - Flat bed broadcasting	51077	25776	25301	0.98
M_2 - Furrow sowing	69964	26276	43688	1.65
M_3 - Flat line sowing	55304	25776	29528	1.14
M_4 - Ridge side sowing	60091	26276	33815	1.28
SEm±	616	-	616	0.02
CD(P=0.05)	2131	-	2131	0.08
Sulphur levels (kg S ha^{-1})				
S_0-0	49579	24276	25303	1.04
S_1-20	54584	25832	28752	1.11
S_2-30	62524	26609	35915	1.35
S_3-40	69749	27387	42362	1.55
SEm±	713	-	713	0.03
CD (P=0.05)	2081	-	2081	0.07

with increasing levels of sulphur application, the seed yield (q ha^{-1}) of mustard improved markedly with increase in sulphur levels up to 40 kg S ha^{-1} over the control. 40 kg S ha^{-1} found superior as production of mustard seed q ha^{-1} than other treatment (20 and 30 kg S $ha^{-1)}$ however 20 kg S ha^{-1} at par with control. It is apparent from the data that stover yield (q ha^{-1}) was influenced due to land configuration methods. With different methods of land configuration there was found significantly difference among the treatments and furrow method of sowing recorded the highest seed yield over other methods. The observation revealed that with increasing of sulphur levels up to 40 kg S ha^{-1} increase in yield of stover and 40 kg S ha^{-1} found significantly higher than other treatment and control and also found that the stover yield is significantly higher with 20 and 30 kg of sulphur per hectare over the control. It is evident from the data that different methods of land configuration and sulphur levels markedly increased the harvest index but the differences could not reach to the level of significance, these finding are conformity with Parihar *et al*. (2010), Kuotsu *et al*. (2014), and Om *et al*. (2013), Chiroma *et al*. (2006), Jyoti *et al*. (2012), Singh and Kumar (2014) Tiwari *et al*. (2003).

Economics

The data pertaining to economics of mustard as influenced by various treatments are presented in Table 3. An insight into the data clearly demonstrated that, there was marked difference in the cost of cultivation, gross return and net return of mustard cultivation under different treatments. The cost of cultivation, gross return and net return was markedly different with different method of land configuration methods; similarly, with each increment of sulphur application there was corresponding increase in cost of cultivation, gross return and net return of mustard cultivation up to 40 kg S ha^{-1}. Data pertaining to benefit: Cost ratio as affected by various treatments is presented in Table 3. A close examination of data revealed improvement in B: C ratio due to different methods of land configuration. Among the all methods, furrow sowing recorded significantly higher B:C ratio fallowed by ridge side sowing, flat bed line sowing and flat bed broadcasting. Further, it was observed that benefit: cost ratio improved with increasing levels of sulphur application up to 40 kg S ha^{-1}, application of 40 kg S ha^{-1} recorded significantly higher B:C ratio over control and 30 and 20 kg S ha^{-1}. This is in conformity with the findings of Om *et al.* (2013), Parihar *et al.* (2009), Parihar *et al.* (2012), Kumar and Trivedi (2011), and Virendra *et al.* (2008).

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