Ann. Agric. Res. New Series Vol. 43 (4) : 434-438 (2022)

Effect of cropping system and nutrient management practices on productivity and profitability of Indian mustard (*Brassica juncea* L.)

Dheerendra Prasad Chaturvedi[1]* and H.S. Kushwaha[2]

Department of Natural Resource Management, Faculty of Agriculture
Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.)-485334
Email: dpchaturvedi79@gmail.com

Received: May 2022; Revised Accepted: October 2022

Abstract

A field experiment was conducted during 2016-17 and 2017-18 at the Research Farm, M G C G V, Chitrakoot Satna (M.P.) to study the effect of cropping system and nutrient management practices on production and profitability of mustard**.** Out of the three cropping systems, greengram-mustard resulted in significantly highest siliquae/plant (137.84; 143.96) and grains/siliqua (12.73; 12.84). The green gram-mustard recorded significantly higher seed yield (1178 and 1283 kg/ha) and stover yield (3918 and 4266 kg/ha) of mustard as compared to sesame-mustard and maize-mustard cropping system. Application of 100% N equivalent through FYM in *kharif* +100% N equivalent through FYM in *rabi* produced highest siliquae/plant (148.23 and 153.43) and seeds/siliqua (12.80 and 12.88) during two respective years. However, the treatment having 200% N through FYM (100% N equivalent through FYM in *kharif* and 100% N equivalent through FYM in mustard) resulted in the maximum seed yield (1092 and 1191 kg/ha) and stover yield (3781 and 4128 kg/ha) of mustard followed by 150% NPK + 5 t FYM /ha (75% NPK+5 t FYM/ha in *kharif* +75% NPK in *rabi)* and (50% NPK+5 t FYM/ha in *kharif* +100% NPK in *rabi*). The mustard after green gram provided maximum net income of ₹46,461/ha with 2.50 B:C ratio. Net returns and B:C ratio of mustard obtained maximum (₹40539/ha; 2.32) under 75% NPK+5 t FYM/ha in *kharif* and 75% NPK in *rabi* season.

Key words: Nutrient management practices, Cropping systems, Profitability, Yield

Introduction

The Indian mustard-based systems play a significant role in crop production in general and improving the economic condition of the farmers in particular. But its profitability and sustainability are not encouraging due to many reasons. Fallow mustard is popular sequence in major mustard growing areas but some of the crops may result in better resources utilization and high remuneration if included in mustard-based cropping system (Lal *et al.*, 2015). However, an introduction of cereals or pulses in the system was found more beneficial than Indian mustard succeeding after fallow (Tripathi and Rathi, 2003). The incorporation of leguminous crops in the rotational and intercropping sequence and use of bacterial and algal cultures play an important role in increasing the nutrient use efficiency. Balance fertilizer has become an accepted strategy to study the effect of different organic, inorganic sources of nutrients alone and in their combination on yield

*Corresponding author's email:
dpchaturvedi79@gmail.com
[1] Part of Ph.D. thesis submitted to MGCGVV, Chitrakoot, Satna (M.P.)
[2]Professor (Agronomy), email: kushwaha_hs@rediffmail.com

and economics of crops. Farmyard manure (FYM) is valuable organic manure that can improve soil health due to its high humus, macro and micro nutrient contents. Besides helping in improvement of soil structure, aeration and water holding capacity of soil, it can stimulate the microbial activity that enhances number of biological processes improving nutrient uptake (Jaisankar and Manivannan, 2018). Kymore Plateau and Satpura hills zone of Madhya Pradesh is a potential area for mustard, soybean, maize, green gram and sesame crops grown by farmers. Therefore there is a need to develop mustard-based cropping system, which can give higher productivity. Keeping these facts in mind, the present investigation was taken up to assess the suitable cropping system and appropriate fertilization schedules for mustard based cropping system.

Materials and Methods

The field experiment was conducted during 2016-17 and 2017-18 at the Agriculture Farm, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidhyalaya, Chitrakoot, Satna (M.P.). The soil of the experimental field was silty clay loam having pH 7.5-7.6, electrical conductivity 0.26-0.29 dSm^{-1}, available N 176.6-186.8 kg/ha, available P 12.5-13.0 kg/ha, available K 216.6-226.8 kg/ha and available S 7.75-8.70 mg/ha, in two respective years. The total rainfall received during experimentation was 744.8 and 844.7 mm, in two consecutive years. The treatments comprised three cropping systems (maize-mustard, sesame-mustard and greengram-mustard) and five balance fertilizer treatments (100% N equivalent through FYM, 100% NPK, 100% NPK + S, 75% NPK + 5 t FYM and 50% NPK + 5 t FYM/ha in *kharif* season and 100% N equivalent through FYM, 0, 50, 75 and 100% NPK in *rabi* season. The experiment was laid out in RBD (factorial) with three replications. Mustard cv. *Pusa Mahak* was sown on 04/11/16 and 28/11/17 at a spacing of 45 cm. x 15cm during two years. The recommended dose of NPK of mustard was estimated 120:60:40 kg/ha as per treatment. All the crops were grown as per recommended package of practices. The *rabi* (mustard) crop was harvested on 10/03/2017 and 09.03.2018 in two respective years. The observation related to growth parameters and biomass productivity of mustard was measured as per standard procedure. Biomass productivity was expressed in term of biological yield. Data generated were subjected to analysis of variance (ANOVA) and critical difference (CD) at 5% probability level was obtained.

Results and Discussion

Yield-attributes

Out of the three cropping systems, greengram-mustard resulted in significantly highest 137.84 and 143.96 siliquae/ plant, 12.73 and

Table 1. Yield-attributing of mustard as influenced by cropping systems and balance fertilization

Treatments		Siliquae/plant		Seeds/siliqua	
		2016-17	2017-18	2016-17	2017-18
Cropping systems					
C_1 Maize-Mustard		124.52	128.38	11.61	11.66
C_2 Sesame-Mustard		132.46	136.32	12.03	12.12
C_3 Greengram-Mustard		137.84	143.96	12.73	12.84
SEm±		0.069	0.091	0.007	0.018
CD(P=0.05)		0.195	0.257	0.020	0.051
Balance Fertilization					
Kharif	Rabi				
B_1 100% N by FYM /ha	100% N by FYM/ha	148.23	153.43	12.80	12.88
B_2 100% NPK (120:60:30)	0%NPK	116.70	119.90	11.17	11.22
B_3 100%NPK+S_{20}	50% NPK	123.40	130.13	11.98	12.10
B_4 75%NPK + 5 t FYM/ha	75%NPK	137.57	140.57	12.38	12.43
B_5 50% NPK + 5 t FYM/ha	100% NPK	132.13	137.07	12.29	12.41
SEm+		0.089	0.117	0.009	0.023
CD(P=0.05)		0.252	0.332	0.026	0.066

12.84 grains/siliquae during two years. The second best cropping system was sesame-mustard. These results could be associated with the superior growth parameters of mustard. Accordingly, the preceding crop greengram proved most beneficial effect on mustard as compared to the preceding crop sesame or maize. The greengram is a legume crop which played unique role on the soil fertility giving multifarious advantages to the following mustard crop. Consequently the yield-attributing parameters were found highest in case of greengram-mustard cropping system. The beneficial effect of legume crops in the cropping systems has also been indicated by Jat *et al.* (2018).

Applied of 200% N equivalent through FYM (100% N equivalent through FYM *kharif* +100% N equivalent through FYM in *rabi*) produced highest 148.23 and 153.43 siliquae/plant, 12.80 and 12.88 seeds/siliqua. This was followed by B_4 (75% NPK+5 t FYM/ha *kharif* +75% NPK in *rabi*) and B_5 (50% NPK+5 t FYM/ha in *kharif* +100% NPK in *rabi*) fertility levels having applied the same 150% NPK + 5 t FYM ha^{-1} and then B_5 (50% NPK +5 t. FYM / ha *kharif* +100% NPK *rabi*) having applied 150% NPK + 100% sulphur (S_{20}). The reason of such results trend is very apparent because the yield-attributes were augmented significantly due to similar increases in growth parameters. This had resulted in greater accumulation of carbohydrates, protein and their translocation to the reproductive organs. These results on mustard are in close agreement with those of Jat *et al.* (2018) and Chandan *et al.* (2019).

Yield of mustard

The greengram-mustard recorded significantly higher seed yield 1178 and 1283 kg/ha) and stover yield (3918 and 4266 kg/ha) of mustard as compared to sesame-mustard and maize-mustard cropping system. The significantly lowest seed yield (846 and 930 kg/ha) and stover yield (3108 and 3446 kg/ha) were obtained from maize-mustard cropping system. This could be ascribed due to greater growth parameters of mustard which enhanced the formation of more reproductive primodia and produce higher seed and straw yield. These results are in close conformity with the observations made by Jat *et al.* (2018).

The treatment having 200% N equivalent through FYM (100% N equivalent through FYM in *kharif* and 100% N through FYM in mustard) resulted in the maximum seed yield (1092 and 1191 kg/ha) and stover yield (3781 and 4128 kg/ha) of mustard. This was followed by the treatments having equal 150% NPK + 5 t FYM/ha (B_4:75% NPK+5 t FYM/ha *kharif* + 75% NPK in *rabi*) and (B_5: 50% NPK +5 t FYM/ha in *kharif* + 100% NPK in r*abi*). The higher productivity in treatments, B_1, B_4 and B_5 was on account of increased growth parameters in these treatments. The results are in the line of Jat *et al.* (2018).

Table 2. Yield of mustard as influenced by cropping systems and balance fertilization

Treatments		Seed yield (kg/ha)		Stover yield (kg/ha)	
		2016-17	2017-18	2016-17	2017-18
Cropping systems					
C_1 Maize-Mustard		846	930	3108	3446
C_2 Sesame-Mustard		980	1080	3455	3779
C_3 Greengram-Mustard		1178	1283	3918	4266
SEm+		13.4	3.5	6.7	13.3
CD(P=0.05)		38.0	10.0	19.0	37.7
Balance fertilization					
Kharif	***Rabi***				
B_1 100% N by FYM/ha	100% N by FYM/ha	1092	1191	3781	4128
B_2 100% NPK (120:60:30)	0 %NPK	856	953	3093	3445
B_3 100% NPK+ S_{20}	50% NPK	985	1064	3514	3675
B_4 75% NPK + 5 t FYM/ha	75% NPK	1071	1173	3605	4072
B_5 50% NPK + 5 t FYM/ha	100% NPK	1004	1106	3476	3832
SEm+		17.3	4.5	8.7	17.2
CD(P=0.05)		49.0	12.8	24.5	48.7

Table 3. Economics of mustard as influenced by cropping systems and balance fertilization (Mean for 2 years)

Treatments			Net returns (₹/ha)	B: C ratio
Cropping systems				
C_1	Maize-Mustard		25077	1.81
C_2	Sesame-Mustard		33950	2.09
C_3	Greengram-Mustard		46461	2.50
	SEm+		-	-
	CD(P=0.05)		-	-
Balance fertilization				
	Kharif	*Rabi*		
B_1	100% N by FYM/ha	100% N by FYM/ha	33675	1.87
B_2	100% NPK (120:60:30)	0 %NPK	30789	2.15
B_3	100% NPK+ S_{20}	50% NPK	35755	2.22
B_4	75% NPK + 5 t FYM/ha	75%NPK	40539	2.32
B_5	50% NPK + 5 t FYM/ha	100% NPK	35055	2.10
	SEm+		-	-
	CD(P=0.05)		-	-

Monetary gains from the Mustard

The data in the Table 3 revealed that amongest the cropping system, the economics of *kharif* crops (maize, sesame and greengram) was estimated separately according to the applied fertility levels. In this case, the mustard after greengram provided maximum net income of ₹46461/ha with 2.50 B:C ratio. This was followed by mustard after sesame (₹33950/ha, 2.09 B:C ratio) and then mustard after maize (₹25077/ha,1.81 B:C ratio). This could be ascribed due to higher seed and stover yield and their greater monitoring value of concerning treatment.

The application of 75% NPK + FYM 5 t./ha in *kharif* + 75% NPK in *rabi* (B_4) estimated higher net returns (₹35755/ha) and B:C ratio (2.22) in mustard followed by 100% NPKS in *kharif* + 50% NPK to mustard (B_3) and 50% NPK + FYM 5 t/ha in *kharif* and 100% NPK in *rabi* (B_5). This could be ascribed due to intermediate order of gross returns with moderate cost of cultivation. Verma and Dawson (2018) was also found maximum net returns and B:C ratio of mustard under 100 % NPK with 15 kg S and 1 kg B/ha.

Conclusion

Thus it can be concluded that greengram-mustard system with 75% NPK + FYM 5 t/ha in *kharif* + 75% NPK in mustard (B_4) was found the best system and appropriate dose of balance fertilization for higher productivity and profitability of mustard in Kymore Plateau of Madhya Pradesh

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