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Research Article

Effect of FYM and Sulphur Doses on Yield Attributes, Yield, Oil Content and Economics of Sole and Intercropped Indian Mustard (*Brassica juncea* L.) in Association with Chickpea (*Cicer arientinum* L.).

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Abstract A field experiment was carriedout for two years (Rabi season of 2009-10 and 2010-11) at C.S. Azad University of Agriculture & Technology, Kanpur. Treatment comprised two cropping system (sole mustard, chickpea + mustard 4:1) under three levels of FYM (@ 0, 5 and 10 t/ha) and sulphur (@ 0 , 30 and 60 kg/ha). Result showed that intercropped mustard produced significantly superior yield attributes such as siliquae/plant, seed/siliqua, siliquae length, 1000-seed weight, seed weight (47.95 g)/plant and oil content in seed (39.27%) but pure mustard gave significantly higher seed yield (20.31 q/ha), stover yield (27.45 q/h), gross return (Rs 53504/ha), net return (Rs. 28303/ha). Application of FYM @ 10 t/ha produced significantly all yield contributing characters, seed yield (15.32 q/ha), stover yield (18.51 q/ha), gross return (Rs. 40068/ha), net return (Rs. 23929/ha) and oil content (40.05 %). Similarly sulphur application @ 60 kg/ha improved yield attributes, seed yield (14.44 q/ha), stover yield (18.06 q/ha), gross return Rs. 37734/ha, net return (Rs. 21637/ha) and oil content in seed (39.41%).

Key word: Sole mustard, intercropped mustard, yield attributes, economics.

Introduction

Mustard is cultivated in mostly under temperate climate. Indian mustard is reported to tolerate annual precipitation of 500 to 4200 mm, annual temperature 6 to 27°C and pH 4.3 to 8.3. Rape and mustard follows C3 pathway for carbon assimilation. Therefore, it has efficient photosynthetic response at 15-28 °C temperature. Indian mustard (Brassica juncea L.) is predominantly cultivated in Rajasthan, UP, Haryana, Madhya Pradesh and Gujarat. This crop can be raised under both irrigated and rainfed conditions. Chickpea and mustard both are Rabi season crops with diverse rooting pattern, phenology and morphology, there is possibility of successfully growing these in intercopping systems. It boosts the productivity of the system giving higher returns and stability to the farming community. In chickpea + mustard intercropping mostly mustard is grown in replacement series either after four row or sixth row of chickpea hence plant stand is poor than sole mustard. Thus yield of mustard can be increased with addition of FYM and sulphur along with recommended doses of NPK. FYM and compost have been traditionally used in agriculture for maintaining soil fertility due to nutrient content, higher organic matter, increased water holding capacity and increased uptake of nutrients and yield stability. Sulphur play direct and prominent role in fatty acid synthesis. It is also required for the synthesis of chlorophyll and vitamins like biotin and thiamine. with these views present investigation was undertaken to evaluate the affect of FYM and sulphur doses on sole and inter cropped mustard.

Material and Methods

A field experiment was conducted during Rabi season of 2009-10 and 2010-11 at student's Instructional Farm of the C.S. Azad University of Agriculture & Technology, Kanpur. Treatment comprised two cropping system i.e. sole mustard and chickpea + Mustard (4:1), three levels of FYM (@ 0, 5 and 10 t/ha) and sulphur (@ 0, 30 and 60 kg/ha). Thus 18 treatments were tested in 3-replicated split plot design in which cropping system and FYM were kept in main plot and sulphur doses in sub plots. The soil of the experimental field was sandy loam in texture having soil pH 7.4, organic carbon 0.40%, available N 169 kg/ha, available P2O5 16.2 kg/ha, available potassium 180 kg/ha and available sulphur 18.2 kg/ha. Chickpea variety KPG-59 and vardan in mustard were used. An uniform application of 120 kg N + 60 kg P2O5 + 40 kg K2O/ha in mustard was done in all sole mustard plots. In

intercropping plots fertilizers were applied raw wise on the basis of actual sown area under each component crop. In chickpea intercropping, chickpea crop fertilized on row basis @ 20 kg N + 40 kg P2O5 + 30 kg K2O/ha. In sole mustard, sowing was done in furrows 40 cm aprt and in intercropping four rows of chickpea were sown at 40 cm apart and in every fifth row one row of mustard was sown (replacement series). The sowing of seed was done on Nov. 25, 2009 and Nov. 15, 2010 during both years behind country plough. Crops were irrigated twice. The crop were protected from weeds and insect pest as per recommendation. The mustard crop was harvested on March 25, 2010 and 2011 and intercropped chickpea on April 3, & 4, 2010 and 2011, respective years. The gross plot size was 6.0 m 4.0 m and net plot size was 4.0 m 3.0 m. All the observations like yield attributes of mustard such as siliquae/plant seed/siliqua, siliqua length, 1000-seed weight, seed weight/plant, seed yield, stover yield, were recorded. The economics have computed with the help of market rates of inputs and produce of crop. The oil content in mustard were estimated with the help of soxhlet kjeldahal apparatus with standard procedure.

$$\text{Percent of oil} = \frac{\text{Weigh to oil}}{\text{Weigh to sample}} \quad 100$$

Result and Discussion

Effect on Yield Attributes of Mustard

Data presented in table-1 indicated that intercropped mustard produced significantly more siliqua/plant than sole mustard by margin of 88.18 siliquae/plant or 20.5%. Application of 5 and 10 t/ha FYM increased number of siliquae over no. FYM by 92.93 (24.1%) and 174.93 siliquae/plant (45.4%), respectively. Similarly sulphur @ 30 and 60 kg/ha improved siliquae number over no sulphur by 25.26 (5.6%) and 43.18 siliquae/plant (9.6%), respectively.

Seeds/siliquae was significantly influenced by all three treatment factors in both years. Intercropped mustard recorded significantly more number of seeds/siluqua than sole by the margin of 1.34 seeds or 11.1%. Increasing levels of FYM increased seeds/siliqua with upto 10 t/ha. Sulphur appliation @ 30 and 60 kg S/ha increased seeds/siliqua over no sulphur (pooled).

It is apparent from table-1 that siliqua length was influenced significantly by main effects of all treatment factors during all years. Intercropped mustard produced significantly more lengthy siliquae compared to sole mustard by 22.0%. FYM application increased siliquae length significantly with upto 10 t/ha FYM, where 5 and 10 t/ha FYM enhanced siliquae length over no FYM by 6.9 and 15.6%, respectively. Sulphur application also improved siliqua length with upto 60 kg/ha but the difference between 30 and 60 kg was not found significant.

It is clear that seed weight/plant was significantly influenced by all three main effects of treatments. Intercropped produced significantly higher seed yield/plant than sole mustard by 12.41 g or 34.9%. Application of sand 10 t/ha FYM improved seed weight/plant to the tune of 10.64 g (33%) and 17.55 g/plant (54.5%), respectively. Sulphur application increased seed weight/plant significantly upto 30 kg/ha and beyond this dose it was numerically increased.

1000-seed weight was not influenced significantly by cropping system but marginal increase was observed in intercropped mustard. FYM application increased 1000-seed weight significantly upto 10 t/ha FYM (17.7%) over no FYM. Application of sulphur increased 1000-seed weight with 60 kg/ha but the difference between 30 and 60 kg was not found significant.

Harvest index (Table-2) was found significantly higher in inter cropped mustard than sole mustard with the margin of 4.27 unit percent. FYM improved harvest index significantly upto 10 t/ha. Sulphur application increased harvest index significantly utp 60 kg/ha but there was not found significant between 30 and 60 kg/ha.

Intercrppped mustard attained higher values of siliquae/plant (518.44), seeds/siliquae 13.45), siliqua length (6.00 cm), seed weight/plant (47.95 g) and harvest index (46.52%) compared to sole mustard. It was because of intercropped mustard raised row spacing of 220 cm (4:1) row ratio and row spacing 40 cm) hence it growth and development was much higher because of plasticity nature of plant. It was might be due to higher branching. Result supported by the findings of Tripathi et al.(2005), Kumar and Singh (2006) and Yadav et al. (2013). Application of 10 t/ha FYM recorded highest values of yield attributes due to positive role of FYM. Since FYM contains almost all essential nutrients, its incorporation in soil promotes rapid vegetative growth, branching, flowering, fruiting and seed setting. Increased yield attributes due to 60 kg S/ha due to sulphur coupled with transport of photosynthesis towards reproductive structure might have increased yield attributes. Result are in live with the findings of Chauhan et al. (2002). Singh and Meena (2004), Singh et al. (2013) and Kumwat et al. (2014).

Effect on Seed and Stover Yield of Mustard

The result (Table-2) revealed that sole mustard produced significantly higher seed yield during both years, which reduced in intercropped mustard by 13.35 q/ha or 65.7% (on pooled basis). Application of FYM @ 5 and 10 t/ha increased seed yield during 2009-10 and 2010-11 significantly by the margin of 2.24 and 3.56 q/ha on pooled basis, respectively. Sulphur application increased seed yield with upto higher level of 60 kg/ha than no sulphur.

Sole mustard recorded significantly higher stover yield during all years of experimentation. On pooled basis intercropped mustard reduced significantly by 19.52 q/ha or 71.1%. FYM application increased stover yield significantly with 5 t/ha over control (1.34 q/ha). Sulphur application had no effect on stover yield of mustard neither year-wise nor in pooled.

The higher seed and stover yield of mustard was recorded higher in sole mustard which reduced significantly by large margins in intercropping system may be attributed to much lower plant population per unit area (20% of pure cropping). The higher yield attributes of intercropped mustard could not compensate the loss in yield. These result are in agreement to the findings of Kumar and Singh (2006), Yadav et al. (2013) and Kour et al. (2014). The effect of FYM and Sulphor on seed stover yield were attributed to yield attributes of mustard. It was probably due to beneficial rate of FYM and sulphur. These results corroborate with the findings of Singh and Pal (2011) and Kumawat et al. (2014.

Effect on Oil Content in Seed of Mustard

It is clear from Table-2 that seed oil content was influenced significantly by all three treatment factors during both years and in pooled. Intercropped mustard registered significantly higher seed oil content than sole mustard. Application on of 5 and 10 t/ha FYM increased seed oil content (0.99 and 1.91 unit percent) over no. FYM. Sulphur application increased seed oil content upto 60 kg S/ha than no sulphur (on pooled basis). It might be attributed to better development of seed in intercropping. Almost similar results were observed by Chand and Tripathi (2005) and Kumar and Singh (2006). Oil content improved by FYM and sulpur application might be due to FYM supplied all essential plant nutrients for crop use and sulphur is directly involved in oil synthesis and protein metabolism. These results are in close conformity to the findings of Singh and Pal (2011), Singh et al. (2013) and Kumawat et al. (2014).

Effect on Economics of Mustard

Result (Table-3) indicate that sole mustard gave higher gross income during both years and in pooled. Intercropped mustard reduced by Rs. 35296/ha or 66.0%. Application of 5 and 10 t/ha FYM increased gross income over no FYM by the margins of Rs 5707 and 9172/ha, respectively. Similarly sulphur application @ 30 and 60 kg/ha increased gross inome of Rs. 1726 and Rs 3680/ha, respectively.

Net income of intercropped mustard reduced by 53.5% compared to sole mustard (on pooled). Application of FYM @ 5 and 10 t/ha gave statistically higher gross income by Rs 4522 and 7051/ha than control (No FYM). Sulphur application @ 30 and 60 kg/ha also showed increase over no sulphur by the margins of Rs. 665 (3.3%), and Rs 1684/ha (8.4%), respectively.

It is evident from Table-3 that B:C ratio was found significantly higher in intercropped mustard than its sole stand. Each increasing level of FYM improved B:C ratio significantly upto 10 t/ha. Sulphur application had no significant effect on B:C ratio.

Sole mustard recorded higher values of gross income and net income than intercropped mustard because of higher plant population per unit area, higher seed and stover yield which is the income of mustard and higher cultivation cost which determine net income. Higher gross income with FYM attributed to higher seed and stover yield with increasing FYM levels. Gross income increased higher rate than increase in cost of cultivation. These results are in agreement with the findings of Singh and Pal (2011) and Kumawat et al. (2014). Gross income with sulphur application might be attributed to seed yield of mustard. Net return might has increased due to gross income increased by higher margin than cultivation cost of sulphur application. These results corroborate with the findings of Singh et al. (1998) and Singh et al. (2013).

Table-1: Effect of treatments on yield attributes of sole and intercropped mustard with chickpea

Treatments	No. of siliquae/plant			No. of Seeds/Siliqua			Siliqua length (cm)			1000-seed weight (g)			Seed weight/plant (g)		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Cropping System															
Sole Mustard	437.26	423.26	430.26	11.70	12.53	12.11	4.83	5.01	4.92	3.97	4.17	4.07	34.75	36.33	35.54
Chickpea + Mustard (4:1)	511.65	525.23	518.44	13.90	13.53	13.45	6.15	5.85	6.00	4.03	4.26	4.14	46.71	48.68	47.95
S.Ed. ±	**3.66**	**3.76**	**3.71**	**0.18**	**0.17**	**0.18**	**0.05**	**0.06**	**0.05**	**0.04**	**0.05**	**0.04**	**0.54**	**0.49**	**0.52**
CD (P=0.05)	**8.16**	**8.37**	**7.73**	**0.41**	**0.38**	**0.37**	**0.11**	**0.13**	**0.11**	**NS**	**NS**	**NS**	**1.19**	**1.11**	**1.07**
FYM (t/ha)															
0	382.09	388.04	385.06	11.55	11.96	11.75	5.14	5.02	5.08	3.68	3.88	3.78	31.40	33.04	32.22
5	480.68	475.31	477.99	12.44	13.26	12.85	5.51	5.35	5.43	3.99	4.20	4.09	41.98	43.73	42.86
10	560.59	559.39	559.49	13.65	13.83	13.74	5.81	5.93	5.87	4.33	4.57	4.45	48.80	50.74	49.77
S.Ed. ±	**4.48**	**4.61**	**4.54**	**0.22**	**0.21**	**0.22**	**0.06**	**0.07**	**0.07**	**0.05**	**0.06**	**0.05**	**0.66**	**0.61**	**0.63**
CD (P=0.05)	**9.99**	**10.26**	**9.46**	**0.50**	**0.47**	**0.45**	**0.14**	**0.16**	**0.14**	**0.11**	**0.12**	**0.11**	**1.46**	**1.35**	**1.32**
Sulphur (kg/ha)															
0	451.94	451.01	451.47	12.17	12.68	12.42	5.35	5.26	5.31	3.85	4.06	3.96	38.88	40.44	39.66
30	427.28	476.37	476.83	12.44	12.99	12.71	5.50	5.45	5.47	4.04	4.24	4.14	41.19	42.74	41.96
60	494.15	495.35	494.75	13.03	13.38	13.20	5.60	5.59	5.60	4.11	4.35	4.23	42.12	44.34	43.23
S.Ed. ±	**4.95**	**4.42**	**4.69**	**0.29**	**0.26**	**0.28**	**0.08**	**0.09**	**0.09**	**0.07**	**0.08**	**0.08**	**0.83**	**0.88**	**0.85**
CD (P=0.05)	**10.22**	**9.11**	**9.29**	**0.61**	**0.54**	**0.55**	**0.17**	**0.20**	**0.18**	**0.15**	**0.17**	**0.16**	**1.7**	**1.8**	**1.69**

Table-2: Effect of treatments on seed yield (q/ha), stover yield (q/ha), harvest index (%) and oil content in seed (%) of sole and intercropped mustard with chickpea

Treatments	Seed yield (q/ha)			Stover yield (q/ha)			Harvest index (%)			Oil content in seed (%)		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Cropping System												
Sole Mustard	20.14	20.47	20.31	27.12	27.86	27.45	42.46	42.24	42.35	38.69	39.21	38.95
Chickpea + Mustard (4:1)	6.88	7.05	6.96	7.84	8.02	7.93	46.42	46.63	46.52	38.94	35.59	39.27
S.Ed. ±	**0.36**	**0.34**	**0.35**	**0.26**	**0.25**	**0.25**	**0.29**	**0.25**	**0.27**	**0.13**	**0.11**	**0.08**
CD (P=0.05)	**0.79**	**0.75**	**0.77**	**0.57**	**0.55**	**0.53**	**0.66**	**0.56**	**0.57**	**NS**	**0.24**	**0.18**
FYM (t/ha)												
0	11.44	11.95	12.69	16.69	16.58	16.63	41.28	42.77	42.03	37.74	38.54	38.14
5	13.84	14.01	13.93	17.66	18.28	17.97	45.15	44.72	44.94	38.78	39.48	39.13
10	15.26	15.32	15.25	18.07	18.96	18.51	46.89	45.81	46.35	39.94	40.16	40.05
S.Ed. ±	**0.43**	**0.41**	**0.42**	**0.32**	**0.30**	**0.31**	**0.36**	**0.31**	**0.34**	**0.16**	**0.13**	**0.11**
CD (P=0.05)	**0.97**	**0.92**	**0.88**	**0.70**	**0.67**	**0.64**	**0.81**	**0.69**	**0.70**	**0.36**	**0.29**	**0.22**
Sulphur (kg/ha)												
0	12.73	13.13	12.93	17.17	17.60	17.38	43.39	43.63	43.51	38.45	39.17	38.81
30	13.50	13.73	13.61	17.47	17.88	17.67	44.44	44.44	44.44	38.84	39.37	39.11
60	14.30	14.44	14.37	17.78	18.34	18.06	45.49	45.23	45.36	39.17	39.64	39.41
S.Ed. ±	**0.58**	**0.48**	**0.53**	**0.51**	**0.59**	**0.55**	**0.47**	**0.51**	**0.49**	**0.13**	**0.18**	**0.16**
CD (P=0.05)	**1.19**	**0.99**	**1.05**	**NS**	**NS**	**NS**	**0.97**	**1.04**	**0.96**	**0.26**	**0.38**	**0.31**

Table-3: Effect of treatments on economics of sole and intercropped mustard grown with chickpea

Treatments	Total cost of cultivation (Rs/ha)	Gross return (Rs/ha)			Net return (Rs/ha)			Benefit: cost ratio		
		2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Cropping System										
Sole Mustard	25200	53056	53952	53504	27855	25751	28303	2.09	2.13	2.11
Chickpea + Mustard (4:1)	5040	17992	18425	18208	12952	13384	13168	3.55	3.64	3.60
S.Ed. ±		**433**	**439**	**308**	**375**	**384**	**268**	**0.05**	**0.05**	**0.04**
CD (P=0.05)		**965**	**978**	**643**	**837**	**855**	**560**	**0.10**	**0.11**	**0.07**
FYM (t/ha)										
0	14018	30271	31522	30896	16253	17504	16878	2.55	2.67	2.61
5	15273	36354	36852	36603	21151	21649	21400	2.90	2.94	2.92
10	16140	39947	40190	40068	23807	24051	23929	3.03	3.04	3.04
S.Ed. ±		**531**	**538**	**378**	**460**	**470**	**329**	**3.06**	**0.07**	**0.04**
CD (P=0.05)		**1182**	**1198**	**788**	**1025**	**1048**	**686**	**0.12**	**0.15**	**0.09**
Sulphur (kg/ha)										
0	14101	33538	34570	34054	19437	20469	19953	2.86	2.92	2.89
30	15162	35500	36060	35780	20338	20898	20618	2.81	2.87	2.84
60	16098	37534	37934	37734	21436	21837	21637	2.81	2.86	2.83
S.Ed. ±		**752**	**754**	**533**	**627**	**648**	**451**	**0.08**	**0.09**	**0.06**
CD (P=0.05)		**1552**	**1157**	**1071**	**1293**	**1337**	**906**	**NS**	**NS**	**NS**

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