The Pharma Innovation Journal 2023; 12(1): 2910-2912

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(1): 2910-2912

www.thepharmajournal.com
Received: 06-10-2022
Accepted: 10-11-2022

Chetanram Dhruw
M.Sc. (Ag.) Scholar, Section of Agronomy, DKS College of Agriculture and Research Station, Bhatapara, Chhattisgarh, India

Dr. TL Kashyap
Senior Scientist (Agronomy) DKS College of Agriculture and Research Station, Bhatapara, Chhattisgarh, India

Dr. PR Mirjha
Assistant Professor (Agronomy) DKS College of Agriculture and Research Station, Bhatapara, Chhattisgarh, India

Corresponding Author:
Chetanram Dhruw
M.Sc. (Ag.) Scholar, Section of Agronomy, DKS College of Agriculture and Research Station, Bhatapara, Chhattisgarh, India

Effect of different row spacing and weed control practices on yield and economics of Mustard (*Brassica juncea*) under vertisols of Chhattisgarh

Chetanram Dhruw, Dr. TL Kashyap and Dr. PR Mirjha

Abstract
The field experiment entitled "Effect of different row spacing and weed control practices on yield and economics of Mustard (*Brassica juncea*) under Vertisols of Chhattisgarh*"* was carried out during *rabi* season of 2020-21 at the Instructional Farm, DKS College of Agriculture and Research Station, Bhatapara. The experiment was laidout in Split Plot Design with 16 treatment combinations comprised of four row spacing and four weed controls treatments with three replication *viz*. main plot (Row Spacing) S_1 - 60 cm, S_2 - Row 40 cm, S_3 - 30 cm, S_4 - 25 cm and Sub plot **(**weed control) W_1 - Weedy check, W_2 - Isoproturon @ 1 kg a.i. ha^{-1} (PE), W_3 - Isoproturon @ 1 kg a.i ha^{-1} (PE) - Fenoxaprop-p-ethyl@0.75kg a.i ha^{-1} at 25 to 30 DAS (PoE) and W_4 - Weed Free. Musturd Cg sarson was sown on 10th November, 2020 at using 5 kg seed ha^{-1} with recommended dose of fertilizer viz. 100, 60 and 40 kg N, P_2O_5 & K_2O ha^{-1} respectively. Crop was harvested on 28th February, 2021.

Keywords: Row spacing, weed control practices, yield, economics, *Brassica juncea*

Introduction
Mustard (*Brassica juncea* L.) is the most important *rabi* oil seed crop grown in India. It is a thermo sensitive as well as photosensitive crop (Ghosh and Chatterjee, 1988). During 2018-19, total area, production and productivity of mustard in the world was around 36.59 million ha, 72.37 million tons and 1980 kg ha^{-1}, respectively. India contributes 19.8% of Mustard production in the total global production, India has fourth position in production after EU, Canada and China. Indian mustard is the third important oil seed crop in India, after Soybean and groundnut. In India total mustard production 9.12mt from 6.12 mha area with an average productivity 1511 kg ha^{-1}, Rajasthan is leading state of mustard production followed by Haryana and Madhya Pradesh, its capturing 40.74% area and 44.97% production of whole production of India. Total mustard production in Chhattisgarh 18.35 thousand tons from 41.43 thousand ha area and average productivity is 443 kg ha^{-1} which is far below than the national productivity 1511 kg ha^{-1}. Maximum mustard producing district is Balrampur (3.74 thousand tons) followed by Surguja (2.64 thousand tons) and Surajpur (1.96 thousand tons). Green tender plant of Mustard is used for preparing vegetable commonly called as "Sarson Ka Sagg". Their oil is utilized for human consumption throughout northern India in cooking and frying purposes. The whole seed is used as condiment in the preparation of pickles and for flavoring curries and vegetables.

Materials and Methods
The field experiment was conducted at the Instructional Farm, Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara, Chhattisgarh during *rabi* season of 2020-21.

Seed yield (kg ha^{-1})
Bundle of harvested crop from each plot were threshed separately and grain were collected in separate bags for each plot. After cleaning the grains were weighted and expressed as kg ha^{-1}.

Total biological yield (kg ha^{-1})
After harvesting of crop and sun drying for four days before threshing mustard bundle were weighted and biological yield was expressed as kg ha^{-1}

Stover yield (kg ha^{-1})
Stover yield was recorded after threshing by subtracting grain weight from bundle weight. That is expressed as kg ha^{-1}.

Harvest index (%)
The harvest index was determined by using the formula given by Donald (1962).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where,
Economic yield = gain yield
Biological yield = grain yield + stover yield

Result and Discussion
Grain yield kg ha^{-1}, Stover yield kg ha^{-1}, Biological yield kg ha^{-1} and harvest index (%)
The data of yields and grain recovery have been presented in Table 1 Mustard requires appropriate space between plants for proper yield. In the present experiment, biological, seed and straw yield as well as harvest index of mustard (values are 5299, 1343, 3980 kg ha^{-1} and 25.98% respectively) were found to increase significantly with the optimum 30 cm of row spacing as compare to extremely closer (25 cm) and wider spacing (60 cm). The lower values viz. Biological yield (4621 kg), grain yield (1093 kg), stover yield (3574 kg) ha^{-1} and harvest index (23.08%), respectively obtained from wider spacing (60 cm) due to decreased plant population unit^{-1} area. The increase in biological, grain, stover yield and harvest index were mainly due to increase in the plant population unit^{-1} area due to closer spacing between rows. The higher harvest index indicates that the it enhanced the transformation of biomass in to seed. The optimum or closest (30 cm) spacing caused proportionately greater increase in grain than in non-grain parts which resulted in higher harvest index of mustard. Das *et al.* (2019) [1] and Reddy *et al.* (2020) [9].
Undoubtedly, the highest biological, seed, straw yield and harvest index of mustard were recorded under the weed free conditions (5467, 1438 and 4282 kg ha^{-1}, and 27.57% respectively) which was followed by Isoproturon @ 1 kg a.i ha^{-1} (PE)+ Fenoxaprop-p-ethyl @ 0.75 kg a.i ha^{-1} at 25 to 30 DAS (PoE) and Isoproturon @ 1 kg a.i. ha^{-1} (PE). Lower of these values were found under weedy check. 35.46% grain yield was recorded higher with weed free condition as compare to weedy check. Weed free condition very effectively and minimized the weed competition at critical stage. As a result, it recorded more number of siliquae plant^{-1}, number of seed siliqua^{-1}, test weight and produced seed yield (1438 kg ha^{-1}). This might be due to adequate nutrient availability and less competition to weeds, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigor of the vegetative growth and yield attributes which resulted in higher yields and HI. The increase in yield was further attributed to better translocation of photosynthates from source to sink due to higher uptake of N which are responsible for quick and easy translocation of photosynthates. Contrary to this, nutrients stress and moisture due to reduced absorbed of nutrients in weedy check provided minimum seed and straw yield due to poor growth and yield attributing characters. The result are in close confirmily weth the findings of Jangir *et al*. (2017) [12], Sharma and Singh, (2002) [13], Chauhan *et al*. (2005) [14].

Effect of weed management practices on economics of Mustard crop.
The data on the economics of mustard as influenced by weed management practices are shown in table 2 Indicated that the maximum economical returns viz. gross and net returns of 115470 and 86000 Rs ha^{-1} with B:C Ratio of 2.92 were obtained under spacing 30 cm which was followed by 107647 and 78177 Rs ha^{-1} with BCR of 2.65 under 25 cm spacing and by 102255 and 72785 Rs ha^{-1} with B:C Ratio of 2.47 under 40 cm of row spacing. Lower of these values found under wider row spacing (60 cm) This was attributed to greater increase in gross realization with optimum spacing (30 cm) under same cost of cultivation, in this treatment resulted in higher net realization and B:C Ratio. These results are conformity with those reported by Singh *et al.* (2006) [11] Pyare *et al.* (2008) [7] and Rajput (2012) [8]. While, Iraddi (2008) [4] reported contradictory results in this regard and concluded that narrow row spacing 30 cm gave higher net returns in mustard crop.
That the maximum economical gain of gross returns Rs 123644 ha^{-1}, net retunes Rs 89899 ha^{-1} and BCR 2.66 was obtained under weed free condition (W_4) which was significantly followed by Rs 113824 ha^{-1}, net retunes Rs 81779 ha^{-1} and BCR 2.55 under (W_3) and by Rs 101953 ha^{-1}, Rs 73508 ha^{-1} and BCR of 2.50 under treatment (W_2). The lower economic realization and B:C ratio were found under weedy check (W_1).These findings are in accordance with those reported by Singh (2006) [11] at Jodhpur (Rajasthan), Sewak *et al*. (2007) [10] at Aligarh (UP), Kumar *et al*. (2012) [6] at Palampur (HP) and Kour *et al*. (2014) [5] at Jammu (J & K).

Table 1: Effect of row spacing and weed control practices on yield and harvest index of Indian mustard

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (%)
Row spacing				
S_1 - 60 cm	1093	3574	4621	23.08
S_2 - 40 cm	1186	3660	4781	24.22
S_3 - 30 cm	1343	3980	5299	25.98
S_4 - 25 cm	1249	3852	5090	24.47
SEm±	18.32	35.29	49.79	0.43
CD (P=0.05)	63.40	122.13	172.28	1.50
Weed management/practices				
Weedy check	928	3150	4183	20.83
Isoproturon @ 1 kg a.i. ha^{-1} (PE)	1181	3707	4888	24.17
Isoproturon @ 1 kg a.i ha^{-1} (PE)-Fenoxaprop-p-ethyl @ 0.75kg a.i ha^{-1} at 25 to 30 DAS (PoE)	1324	3929	5254	25.69
Weed Free	1438	4282	5467	27.57

SEm±	21.01	56.03	65.14	0.35
CD (P=0.05)	61.32	163.53	190.13	1.02
Interaction				
SEm±	42.02	112	130.28	0.70
CD (P=0.05)	122.65	327	318.35	2.07

*PE- Pre emergence, PoE- Post emergence

Table 2: Effect of row spacing and weed control practices on economics of Indian mustard

Treatments	Cost of cultivation (Rs ha$^{-1)}$	Gross returns (Rs ha$^{-1)}$	Net returns (Rs ha$^{-1)}$	B:C ratio
Row spacing				
S_1 - 60 cm	29470	94615	65145	2.21
S_2 - 40 cm	29470	102255	72785	2.47
S_3 - 30 cm	29470	115470	86000	2.92
S_4 - 25 cm	29470	107647	78177	2.65
SEm±	-	1441	49.79	-
CD(P=0.05)	-	4986	172.28	-
Weed managements				
Weedy check	25645	80567	54922	2.14
Isoproturon @ 1 kg a.i. ha^{-1} (PE)	26445	101953	73508	2.50
Isoproturon @ 1 kg a.i ha^{-1} (PE)- Fenoxaprop-p-ethyl@0.75kg a.i ha^{-1} at 25 to 30 DAS(PoE)	32045	113824	81779	2.55
Weed Free	33745	123644	89899	2.66
SEm±	-	1707	-	-
CD(P=0.05)	-	4982	-	-

*PE- Pre emergence, PoE- Post emergence

Conclusions

Weed free treatment recorded maximum grain yield (1438 kg ha^{-1}), Stover yield (4282 kg ha^{-1}) biological yield (5467 kg ha^{-1}) and harvest index (27.57%) as compare to rest of the treatments. Second best treatment was found with Isoproturon @ 1 kg a.i ha^{-1} (PE) + Fenoxaprop-p-ethyl @ 0.75kg a.i ha^{-1} at 25 to 30 DAS (PoE) (biological 5254, grain 1324, stover yield 3929 kg ha^{-1} and harvest index 25.69%, respectively). And the higher economic returns in terms of gross, net returns and B:C ratio their values were 123644, 89899 Rs ha^{-1} and 2.66 respectively obtained in weed free condition which was significantly followed by Isoproturon @ 1 kg a.i ha^{-1} (PE) - Fenoxaprop-p-ethyl @ 0.75kg a.i ha^{-1} at 25 to 30 DAS (PoE) and Isoproturon @ 1 kg a.i. ha^{-1} (PE). Lower net returns and B:C ration were recorded under weedy check condition.

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