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Performance analysis of rapeseed-mustard crop under different agro-climatic conditions of Jammu Division of J & K state

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ABSTRACT

Rapeseed-mustard is the second most important edible oilseed crop in India after groundnut. It has to play a significant role in making India self-reliant in oilseed sector. At present contribution of India to the world acreage and production is 19.29% and 11.12% respectively. Productivity of rapeseed mustard in J & K is 6.98 q/ha which is 37.72% of global productivity and 67.85% of national productivity. Keeping in view low productivity of rapeseed mustard crop in J & K state, a study was undertaken with randomly selected 200 rapeseed mustard growers 100 each from subtropical and temperate zone of Jammu division covering Jammu, Samba, Reasi and Doda districts to ascertain the performance of rapeseed mustard crop under farmer field conditions. Multiple linear regression model was applied to work out the factors affecting productivity of rapeseed mustard crop. The results revealed that proper irrigation, spray of insecticide, proper sowing method, thinning, use of basal dose of urea at sowing time and proper weed management significantly affected the productivity of Indian mustard (*Brassica juncea*) with R^2 value 0.534. The drivers of productivity of gobhi sarson (*Brassica napus*) were proper time of sowing and irrigation with R^2 value 0.253 while use of phosphorus and irrigation at proper time were found to be significantly affecting the productivity of toria (*Brassica rapa*) with R^2 value 0.757. The factors affecting the productivity of hybrid gobhi sarson were proper weed control and knowledge about different production recommendations with R^2 value 0.080.

Key words: Agro-climate, Gobhi sarson, Indian mustard, Multiple linear regression, Productivity, Rapeseed mustard, Toria

Cereals contribute major share in total agriculture production. After cereals, oilseeds constitutes the second largest agricultural commodity in India accounting for 13% of the gross cropped area, 3% of the Gross National Product (GNP) and 10% value of all the agricultural commodities. Despite being the largest cultivator of oilseeds in the world, India imports about 50% of the requirements because of the life style changes in dietary pattern and increased per capita income. The growth in production of domestic edible oils (9.22 million tonnes in 2012-13) has not been able to keep pace with the growth in consumption and the gap between production and consumption is being met through imports. (MoA and FW, GoI 2014). India grows nine major oilseed crops, i.e. soybean, groundnut, sunflower, safflower, castor, sesame, linseed, rapeseed mustard and niger on an area of 27.02 million ha, with productivity of 1108 kg/ha (Vision document 2050-Indian Institute of Oilseed Research).

Among different oilseed crops rapeseed-mustard is the second most important edible oilseed crop in India after groundnut. Rapeseed-mustard is a group of crops comprising rapeseed (toria, brown sarson and yellow sarson) cultivar of *Brassica campestris;* Indian mustard (*Brassica juncea*); black mustard (*Brassica nigra*) and taramira (*Eruca sativa*). Out of these cultivars Indian mustard fits well in cropping system of rainfed areas and accounts for more than 75% of the total area under rapeseed-mustard cultivation in India followed by *toria*, yellow *sarson* and brown *sarson*. Gobhi sarson is under cultivation over a limited area in HP, J&K and Punjab under irrigated ecologies. India occupies the first position in area and third in production in the world, accounting for about 12% of the world's total rapeseed-mustard "seed" and about 8.5% of the world's total rapeseed-mustard "oil". Indian contribution to the world acreage and production is 19.29% and 11.12% respectively (DRMR 2015). Rapeseed mustard is a major oilseed crop of *rabi* season in Jammu and Kashmir. In J&K total area under rapeseed mustard crop is 55236 ha and in

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Jammu province about 11241 ha which comprises both temperate and sub-tropical area. Average productivity of rapeseed mustard in J&K is 6.99 q/ha which is 37.72% of global productivity and 67.85% of national productivity. (Directorate of Agriculture, Jammu 2015-16). Rapeseed mustard is cultivated both in temperate and sub-tropical regions. Non-adoption of recommended varieties is the main reason for low productivity of rapeseed mustard in sub-tropical regions of Jammu division (Ajrawat *et al.* 2013). Keeping in view the low productivity of rapeseed mustard crop in general in J&K and Jammu division in particular, the present research attempted to ascertain the reasons for low productivity and factors affecting productivity of rapeseed mustard crop.

MATERIALS AND METHODS

Stratified random sampling technique was applied to select the districts for the present study. The study area was divided into two strata on the basis of agro-climatic conditions, i.e. sub-tropical and temperate zones. From the sub-tropical zone; Jammu and Samba districts and from temperate zone Reasi and Doda districts were selected on the basis of maximum area under rapeseed mustard crop. Further from each selected district; two blocks were delineated on the basis of maximum area, thus comprising a total of eight blocks for the present study. A list of 1177 rapeseed mustard growers was obtained from relevant agencies from all the blocks. Out of list, 50 rapeseed mustard growers from each study district were selected randomly with the help of random number generator, thereby making a total sample size of 200 rapeseed mustard growers, 100 each from subtropical and temperate zone of Jammu division. The sample size was 17% of total population size. Data were collected from the sampled respondent on the pre-tested interview schedule by contacting personally to the farmers on their fields or at their homes. Analysis of collected data was performed using SPSS (statistical package for social sciences) software. Multiple linear regression model was applied to work out various factors affecting the productivity of rapeseed mustard crop under farmers' field conditions.

RESULTS AND DISCUSSION

Analyzed data in Table 1 reveals the descriptive statistics of some important independent variables which affect the decision of farmers under actual field conditions for getting the optimum production of rapeseed mustard crop. Average age of sampled mustard growers was 49 years and average formal number of school years completed was seven years which gives sufficient indications of lack of educational competencies among farming communities in rural areas. The findings are in line with and Slathia *et al.* (2016) in which it was reported that majority of oilseed growers belong to middle age category. Average operational land holding of sampled mustard growers was 1.647 ha which was higher than the state average land holding of 0.76 ha which suggests that mainly those farmers cultivate this important oilseed crop who had land holding size sufficient enough to diversify their farms by growing oilseed crop and farmers with small land holding size mainly concentrate on fulfilling the needs of cereal crops on priority basis. Status of irrigation is very poor mainly in temperate zone of study area where rapeseed mustard crop is mainly grown as rainfed crop which affects the productivity of this important oilseed crop to a considerable extent. Average farming experience of the sampled farmers was 26 years which indicates that farming is one of the important economic activities of farm families since long for earning their livelihood. This finding got little support from Nain and Chandel (2010), Kumar *et al.* (2010) and Peshin *et al.* (2013) in which it was reported that farmers had good experience of agriculture due to their involvement in this profession from very beginning but they also reported that only one fourth households in Jammu region are exclusively dependent on farming for their livelihood.

The data presented in Table 2 shows distribution of sampled rapeseed mustard growers on the basis of type of rapeseed mustard crop grown. In Samba district, 42% growers had grown gobhi sarson (*Brassica napus*) followed by 24% who had grown toria (*Brassica rapa*), 22% had grown raya (*Brassica juncea*), 14% had grown toria and gobhi sarson as mixed crop and 2% growers had grown hybrid gobhi sarson also. In Jammu district, 44% growers cultivated raya followed by 28% who had grown gobhi sarson, 20% had grown hybrid gobhi sarson, 12% had grown toria and only 4% had grown toria and gobhi sarson as mixed crop. In Reasi district 88% growers cultivated raya

Table 1 Descriptive statistics of sampled rapeseed mustard growers

Particulars	Districts				Overall percentage (n=200)
	Sub-tropical zone		Temperate zone		
	Samba (n=50)	Jammu (n=50)	Reasi (n=50)	Doda (n=50)	
Average age (years) SD	51.20±14.37	51.10±11.35	46.64±11.24	47.14±13.09	49.02±12.67
Average education(formal no. of schooling years completed) SD	7.47±4.04	9.34±4.07	5.66±5	8.42±3.55	7.79±4.39
Average operational land holding (ha) SD	1.81±2.12	1.62±1.314	2.08±1.743	1.07±.97	1.647±1.63
Average irrigated land holding	1.22±2.2	1.57±1.32	.186±3.4	.116±0.32	.772±1.44
Average unirrigated land holding	.594±1.01	.049±.147	1.916±1.58	.977±.96	.884±1.25
Farming experience (years) SD	29.84±12.99	27±10.29	25±9.92	23.48±12.36	26.33±11.63

SD, Standard Deviation

Table 2 Distribution of sampled rapeseed mustard growers on the basis of type of rapeseed mustard crop grown

Type of rapeseed mustard crop grown	Samba n =50	Jammu n =50	Reasi n =50	Doda n =50	Overall percent n=200
Indian mustard *Brassica compestris*	22 *(Brassica juncea)*	44 *(Brassica juncea)*	88 (*Brassica campestris*)	100 (*Brassica campestris*)	63
Toria	24	12	6		10
Gobhi sarson	42	28	6		19
Hybrid gobhi sarson	2	20			6
Toria+ gobhi sarson (mixed cropping)	14	4			5
Area under rapeseed mustard crop					
Total area under rapeseed mustard crop (in ha)	6.91	7.49	18.97	7.0	40.37
Total irrigated area under rapeseed mustard crop	3.12 (45%)	6.84 (91)	Un-irrigated	Un-irrigated	9.96 (25%)

*Multiple responses

Table 3 Adoption of recommended production and protection practices by sampled farmers (% of farmers)

Practices followed	Samba n=50	Jammu n=50	Reasi n=50	Doda n=50	Overall total n=200
Recommended varieties	34	39	14	10	48.5
Fertilizers used	76	96	38	34	61
Herbicides		4			01
Irrigation	52	92			36
Plant protection measures adopted	16	40		14	18

followed by 6% growers who had grown toria and similar percent of farmers had grown gobhi sarson. In Doda district 100% growers had grown raya crop.

Overall 63% growers had grown raya followed by 19% growers who had grown gobhi sarson, 10% had grown toria, 6% had grown hybrid gobhi sarson and only 5% had grown toria and gobhi sarson as mixed crop. Data presented in table also revealed that overall only 25% area under rapeseed mustard crop had assured irrigation facility. The entire area under rapeseed mustard crop in sampled temperate zone was rainfed.

Data in Table 3 depicts the status of adoption of important critical recommendations in the production of rapeseed mustard crop by the sampled farmers. As far as cultivation of recommended varieties is concerned, overall only 48.5% farmers adopted the cultivation of recommended varieties of rapeseed mustard crop and it was very low particularly in Reasi and Doda districts of temperate zone which was one of the major hindrance in achieving the potential yield of rapeseed mustard crop in study area. Use of fertilizers in the production of rapeseed mustard crop was satisfactory but it was again on lower sides in hilly Reasi and Doda districts, where farmers mainly rely on farm yard manure for fulfilling the nutrient requirements of all the crops including rapeseed mustard crop. Among the fertilizers used by the farmers, major thrust was on using urea and DAP fertilizers and use of potash and sulphur fertilizer was almost negligible to which mustard crop respond very well. Further use of herbicides for checking weed problem in mustard crop was almost negligible which may be due to complexity of use of herbicides in mustard crop on the part of farmers. Moreover, farmers reported that they rely on hand weeding but it involved huge level of drudgery, time and investments.

Regarding application of irrigation in rapeseed mustard crop, overall only 36% farmers irrigated their mustard crop. It is mainly grown as rainfed crop in Reasi and Doda districts of temperate and hilly study area due to non-availability of irrigation facilities and they entirely depend upon rainfall for fulfilling the water requirements of all their crops including rapeseed mustard crop and its failure at critical stages of crops largely affects the productivity. With respect to plant protection measures for protecting rapeseed mustard crop mainly from the aphid (*Lipaphis erysimi*) attack, overall only 18% sampled farmers sprayed against deadly aphid insect. Thus from above results, it may be interpreted that majority of the farmers did not show any seriousness in fulfilling the critical inputs for growing rapeseed mustard crop which in turn affect the performance of rapeseed mustard crop at farmers field in term of productivity. The present findings concerned with use of different critical inputs in rapeseed mustard crop adequately supported by study conducted by Monayemmiah *et al.* (2015), Kumar *et al.* (2016), Meena and Shekhwat (2015), Bhagat *et al.* (2002) and Sharma *et al*. (2014).

Figures regarding productivity of rapeseed mustard crop given in Table 4 show that average productivity of rapeseed mustard crop was highest (11.52 q/ha) in Jammu district followed by 7.27 q, 4.10 q and 2.77 q/ha in Samba, Doda and Reasi districts respectively. Overall average productivity of rapeseed mustard crop in all the sampled districts was 6.65 q/ha. With regard to productivity of different crops under major rapeseed mustard group it was found that average productivity of hybrid gobhi sarson was 17.54 q/ha followed by 10.14 q/ha of toria, 8.98 q/ha of mixed crop, 8.58 q/ha of gobhi sarson and 4.42 q/ha of Indian mustard.

Table 4 Average productivity of different rapeseed mustard group of crops obtained under farmer field conditions

Rapeseed mustard crop	Samba n=50	Jammu n=50	Reasi n=50	Doda n=50	Overall average n=200
Indian mustard (Raya)/Brown mustard	3.98z	8.49	2.74 (Brown mustard)	4.10 (Brown mustard)	4.42
Gobhi sarson	7.52	11.34	3.2		8.58
Toria	8.24	12.33	2.85		10.14
Hybrid (PAC-401)	20	17.3			17.54
Mixed (cropping) Toria+ Gobhi sarson	8.19	11.75			8.98
Average productivity (q/ha)	7.27 (± 4.90)	11.52 (±5.65)	2.77 (±1.64)	4.10 (± 2.80)	

Overall average productivity= 6.65q/ha

Data in Table 5 reveal average productivity of different rapeseed mustard group of crops under irrigated and un-irrigated conditions in study area. The average productivity of Indian mustard, gobhi sarson, and toria under irrigated conditions was 8.14, 9.38 and 12.92 q/ha, whereas under un-irrigated conditions it was 3.53, 7.04 and 5.66 q/ha respectively. These productivity figures clearly show the effect of irrigation on achieving the higher productivity of rapeseed mustard crop.

Data presented in Table 6 show difference of overall average rapeseed mustard productivity of sub-tropical and temperate zone with the average productivity of sampled blocks falling under sub-tropical and temperate zone on the basis of one-sample t-test. In case of sub-tropical zone one-sample t-test so applied gave *t*-value of – 0.068 with three degrees of freedom. Test value was 9.43 for assessing the significance of difference. The corresponding two-tailed *p* value was 0.950 which is more than 0.05 and it indicates that there is no significant difference between average rapeseed mustard productivity of the subtropical zone and average productivity of the four sampled sub-tropical blocks.

Similarly in case of analysis of temperate zone productivity, the corresponding two-tailed *p* value so obtained was 0.942 which is more than 0.05 and it suggests that there is no significant difference between average rapeseed mustard productivity of the temperate zone and the average productivity of the four sampled temperate blocks.

The data presented in Table 6 show average productivity of different varieties under actual field conditions as reported by respondent mustard growers. PAC-401 variety of hybrid gobhi sarson was the leading variety with average productivity of 19 q/ha followed by 17 q/ha of RSPT-1 variety of toria. Pusa Vijay and RSPR-1 variety of Indian mustard had the same average productivity of 16 q/ha and in case of Giriraj variety of Indian mustard also it was 12 q/ha. The average productivity of DGS-1 variety of gobhi sarson was 16 q/ha.

Table 5 Average productivity of rapeseed mustard crops of sampled farmers under irrigated and un-irrigated conditions (q/ha)

Rapeseed mustard crops	Productivity (q/ha) Irri-gated	Productivity (q/ha) Un-irrigated
Indian mustard	8.14	3.53
Gobhi sarson	9.38	7.04
Toria	12.92	5.66

Table 6 One sample t-test for testing the difference of overall average rapeseed mustard productivity of sub-tropical and temperate zone

Sub-tropical zone	Test value = 9.43			
	t	df	p-value (2-tailed)	Mean difference
Average productivity	-0.068	3	0.950	-0.12000
Temperate zone	*Test Value = 3.41*			
	t	df	p-value (2-tailed)	Mean Difference
Average productivity	0.078	2	0.942	0.03000

Table 7 Performance of different varieties under actual field conditions

Variety	Max. productivity (q/ha)	Min. productivity (q/ha)	Average productivity (q/ha)	Max oil content (%age)	Average oil content (%age)
SKUAST-J developed varieties					
DGS-1	18	14	16	42	32
RSPT-1	20	14	17	40	31
RSPR-1	16		16	42	32
Other varieties					
Hybrid (PAC-401) Hyola	25	10	19	43	33
Pusa Vijay			16		
Giriraj			12		
KOS-1, KS-101	16	2	3.44	46	35

Factors affecting productivity of rapeseed mustard crop have been shown in Table 7. In case of raya, out of 15 independent variables; irrigation, insecticide spray, staking, sowing method, thinning, basal dose of urea, weed management and sowing time significantly affected the

Table 8 Determinants of productivity of rapeseed mustard crop (Multiple Linear Regressions)

Rapeseed mustard	Independent variables	Co-efficient B	Standard error	t-value	p-value	Model summary
Indian Mustard	(Constant)	0.815	0.614	1.327	0.187	R^2 =0.534
	Irrigation	1.807	0.746	2.422	0.017	Adjusted R square=0.503
	Insecticide spray	2.991	0.793	3.771	0.000	F-value=16.787 p=0.000
	Staking	2.135	0.603	3.539	0.001	
	Sowing method	9.541	2.655	3.593	0.000	
	Thinning	2.921	0.976	2.993	0.003	
	Urea basal dose	0.017	0.007	2.514	0.013	
	Weed management	-1.587	0.674	-2.354	0.020	
	Sowing time	1.016	0.507	2.004	0.047	
Gobhi sarson	(Constant)	3.790	1.539	2.462	0.019	R^2 =0.253
	Irrigation	5.415	1.684	3.215	0.003	Adjusted R square=0.210
	Time of sowing	3.877	1.842	2.105	0.043	F-value=5.929 p=0.006
Toria	(Constant)	1.685	1.145	1.472	0.158	R^2 =0.757
	Irrigation	7.349	1.335	5.504	0.000	Adjusted R square=0.730
	DAP	0.119	0.025	4.735	0.000	F-value=28.029 p=0.000
Hybrid gobhi sarson	(Constant)	-2.842	5.188	0-.548	0.599	R^2 =0.802Adjusted R square=0.753
	Herbicide used	6.507	1.324	4.913	0.001	F-value=16.216 p=0.002
	Knowledge	1.599	0.449	3.563	0.007	

* Significant at P=0.05, ** Significant at P=0.05

productivity of raya with R^2 value 0.534 which means 53% variation in raya productivity was due to these production factors. In case of gobhi sarson, irrigation and time of sowing significantly affected the productivity of gobhi sarson with R^2 value 0.253 which means 25% variation in gobhi sarson productivity was due to these variables. In case of toria weed control and DAP used significantly affected the productivity of toria crop with R^2 value 0.757 which means 75% variation in productivity of toria crop was due to these independent variables under study. In case of hybrid gobhi sarson proper weed control and knowledge about different production recommendations significantly affected the productivity of hybrid gobhi sarson with R^2 value 0.802 which means 80 per cent variation in productivity of hybrid gobhi sarson was due to these independent variables. The present findings of productivity of different rapeseed mustard group of crops got support from the study conducted by Bairathi *et al.* (2013) on rapeseed mustard crop in which it was reported that factors responsible for low productivity were higher seed rate, delayed sowing time, imbalance use of chemical fertilizers, no or less plant protection measures, no weed management and use of old varieties. It is also interpreted from the results that productivity of rapeseed mustard crop was low in hilly districts of study area as compared to districts having plain topography. Similar results were reported by Nain and Chandel (2013) where farm practices in case of field crops like seed components and plant protection were adopted less in hilly areas of Doda district. This finding got support of study conducted by Wollni *et al*. (2010) which reports that approximately 54% of total agricultural land worldwide is located in dryland and hilly areas. This situation not only makes these lands more susceptible to land degradation, desertification and crop yield decline, but also increases crop production costs in the long run.

Table 9 District wise one way analysis of variance in mean difference of productivity of rapeseed mustard crop

Variable	(I) Dist-ricts	(J) Dist-ricts	Mean Difference (I-J)	Std. Error	p-value	Model summary
Product-ivity	Samba	Jammu	-4.24816*	0.80853	0.000	F = 49.281 P= 0.000
		Reasi	4.66001*	0.82425	0.000	
		Doda	3.65721*	0.82425	0.000	
	Jammu	Samba	4.24816*	0.80853	0.000	
		Reasi	8.90817*	0.81673	0.000	
		Doda	7.90537*	0.81673	0.000	
	Reasi	Samba	-4.66001*	0.82425	0.000	
		Jammu	-8.90817*	0.81673	0.000	
		Doda	-1.00280	0.83229	0.230	
	Doda	Samba	-3.65721*	0.82425	0.000	
		Jammu	-7.90537*	0.81673	0.000	
		Reasi	1.00280	0.83229	0.230	

* The mean difference is significant at the 1% level of probability.

Data presented in Table 9 show mean difference in productivity of rapeseed mustard crop in different sampled districts. From the analysis of data it was found that except between Doda and Reasi districts there was significant difference in productivity of rapeseed mustard crop between all the other sampled districts.

Conclusion

Indian mustard was the main crop under rapeseed mustard group which was predominately grown by the sampled farmers in sub-tropical zone. However varieties of brown mustard, i.e. KS-101 and KOS-1 were mainly grown by the farmers in the temperate areas. Gobhi sarson and toria were mainly grown by mustard growers of Jammu and Samba districts. Three-fourth of sampled rapeseed mustard area was rainfed, which was the main reason for overall low productivity in study area. There was significant difference in productivity of rapeseed mustard crop in sub-tropical and temperate zone. It is clear that timely irrigation, application of herbicides, adoption of plant protection measures and proper nutrient management practices significantly affected the productivity of different rapeseed mustard group of crops, therefore concerned agencies in the field of agriculture should work to ensure the availability of these critical inputs in order to increase the productivity to achieve self-sufficiency in oilseed sector. Also adaptive research initiatives should be undertaken by the concerned stakeholders to develop location specific mustard varieties which may respond to the varying climatic conditions. Local germplasm/land races of rapeseed mustard grown by the farmers may be collected by concerned agencies to characterize important traits which could be further promoted. Short duration varieties especially for temperate regions need to be developed and promoted suiting to the present cropping pattern. Horizontal and vertical intensification in rapeseed mustard production needs to be looked into seriously.

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