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Effect of Irrigation and Zinc on quality and nutrient uptake by Indian Mustard (*Brassica juncea*(L.)

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Abstract:

A field experiment was carried out at Instructional Farm, Agronomy, Rajasthan College of Agriculture, Udaipur during rabi2020-21. The experiment was arranged in split plot design having 12 treatment combinations replicated four times. The experiment having three levels of irrigation (one irrigation at seedling stage, two irrigations at seedling + pod formation stage and three irrigations at seedling+50% flowering+ pod formation stage) in main plots and four levels of zinc (control, 4 kg Zn ha^{-1}, 8 kg Zn ha^{-1} and 12 kg Zn ha^{-1}) in sub plots.The results revealed that three irrigations given at seedling, 50% flowering and pod formation stage significantly increased oil content, oil yield and protein yield, as compared to only one irrigation given at seedling stage. Whereas, treatments I_2 (two irrigationsat seedling and pod formation stage) and I_3 (three irrigations at seedling, 50% flowering and pod formation stage) were remained statistically at par.Irrigation frequency had no any significant effect on protein content, nutrient (N, P, K and Zn) content in seed and stoverof mustard crop. Maximum oil content, oil yield, protein content and protein yield were obtained with application of 12 kg Zn ha^{-1}. Whereas, treatments Zn_8 (8 kg Zn ha^{-1}) and Zn_{12} (12 kg Zn ha^{-1}) were remained at par. Nitrogen, potassium and zinc content and uptake by seed and stover of mustard increased significantly with application of 12 kg Zn ha^{-1} over control. Phosphorus content in seed and stover decreased with increasing levels of zinc.

Keywords*: Mustard, Irrigation, Zinc, oil content, protein content, nutrient content and uptake*

Introduction:

Indian mustard (*Brassica juncea* L.) is one of the very important oilseed crops in India. During 2018-19, rapeseed-mustard contributes 24.7% to total area and 29.4% to total production of oilseeds.Rajasthan, Haryana, Madhya Pradesh, Uttar Pradesh, West Bengal, Assam and Gujarat are the major rapeseed-mustard growing states in India, accounting for 92.7% of the area and 95.8% of production in 2017-18, whereas Rajasthan alone accounting for 36.6% and 40.9% of the area and production, respectively(Anonymous, 2019).Water scarcity in Rajasthan is one of the most crucial factors affecting every aspect of life (Kookana*et al.* 2016). Further, the morphometric characteristics of an area significantly affect the availability of groundwater (Kumar *et al.* 2015). Unavailability of sufficient irrigation water is one of the most importantcauses for low productivity of mustard. Again, the quality of water plays an important role in production of crops (Yadav and Singh 2018). In semi-arid climate of Northern India, water stress and the deficiency of nutrients, particularly of micronutrients are two main constraints which affect mustard production (Garnayak*et al*., 2000). Deficiency of organic carbon with poor microbial population is the indicators of poor soil health (Chandar*et al.* 2012; Yadav *et al.* 2021). The number of irrigations is critical for determining mustard's quality.Zinc is an important micronutrient with specific physiological roles in all living systems, including maintaining the structural and functional integrity of biological membranes, as well as facilitating protein synthesis and gene expression (Alloway, 2008).Zinc plays an important role in oil content, protein content, nutrient content and uptake of mustard (Aswal and Yadav, 2007).Mustard is highly vulnerable to micronutrient deficiencies, particularly zinc because it is found deficient in many areas of Rajasthan (Singh *et al.* 2013).Therefore, the present study was under taken to evaluate the effect of irrigation y and zinc on quality, nutrient content and uptake byIndian mustard.

Materials and Methods:

Description of the study area

The experiment was conducted during *rabi* season of the year 2020-21 at Instructional Farm, Rajasthan College of Agriculture, Udaipur.The coordinates of experimental site are 24˚34' N latitude and 73˚42' E longitude and altitude is 582.17 m above mean sea level. The area covered the agro-climatic zone IV-a of Rajasthan having hard-rock characteristics (Machiwal*et al.* 2017).The soil analysis showed that the soil of experimental field was clay loam,slightly alkaline in reaction, medium in available nitrogen and phosphorus and high in available potassium and low in DTPA zinc.

Experimental details

The experiment comprises ofthree levels of irrigation (one irrigation at seedling stage, two irrigations at seedling + pod formation stage and three irrigations at seedling+50% flowering+ pod formation stage) in main plots and four levels of zinc (control, 4 kg Zn ha^{-1}, 8 kg Zn ha^{-1} and 12 kg Zn ha^{-1}) in sub plots,thereby making 12 treatment combinations, were laid out in split plot design with 4 replications.The seed was sown manually on 22 October 2020 by placing 2 seeds at a depth of 3–4 cm.Thinning was done after 25-30 days after sowing (DAS) maintaining row to row and plant to plant distance 30 x 10 cm. Inorder to minimize weed competition, a hand weeding was also done at the time of thinning.Irrigations were given to mustard crop according to the treatments.Recommended dose of NPS*viz.,* 60 kg N, 40 kg $P_2O_5$and 250 kg gypsum per hectare was applied uniformly using urea, DAP and gypsum, respectively.Oil content, oil yield, protein content, protein yield, nutrient content and uptake recorded and analyzed statistically.The field water balance equation was used to calculate evapo-transpiration (ET), as given below:

$$ET = (P + I + C) - (R + D + \Delta S)$$

Where, ET = evapo-transpiration in mm, I = irrigation (mm), P = precipitation (mm), C= capillary rise (mm), D = deep percolation (mm),R = runoff (mm) and ΔS = change in profile soil moisture (mm). C was considered to be negligible as the groundwater table was quite deep (10–15 m). The field plots had no runoff (R) because they were bunded to a sufficient height, and no overflow was observed onbund during the study period. The deep percolation out of the root zone is considered negligible because the applied irrigation water was always substantially below the field capacity of the soil profile. Thus the above equation simplifies to,

$$ET = (P + I) - \Delta S$$

The gravimetric method was used to calculate the changes in soil moisture content (ΔS).

Results and Discussion:

Effect of irrigation on nutrient content, uptake and quality of mustard:

The oil content in mustard seed and oil yield increased significantly with increasing number of irrigations (Table 1). The increase in oil content due to increased irrigation numbers was due to bolder seeds produced by raising irrigation levels, as evidenced by increased test weight as a result of greater moisture levels. Whereas, increase in oil yield as a result of increased seed yield. Further, Protein content in seeds did not increase considerably when irrigation levels increased, but protein yield did, possibly due to higher seed yield. The outcomes are in accordance with the findings of Ray *et al*. (2015); Singh and Thenua (2017).

The data in the Tables 2 and 3 showed that the concentration of N, P, K, and Zn in mustard seed and stover did not change considerably with increasing irrigation frequency. The uptake of these nutrients by mustard seed and stover increased significantly with increasing irrigations. It could be because of higher seed and stover yields at different phenological stages of crop growth when there is enough moisture. These results are in conformity with findings of Verma*et al*. (2018) and Mishra *et al*. (2019).

Effect of zinc fertilization on nutrient content, uptake and quality of mustard:

It is evident from the results (Table 1) that oil content and protein content in mustard seed, as well as oil and protein yield increased significantly with increasing levels of zinc upto 8 kg Zn ha^{-1} over control. The maximum oil content, protein content, oil yield and protein yield were obtained under 12 kg Zn ha^{-1}. Oil and protein content in seed increased by 2.40 and 3.42 percent with application of 12 kg Zn ha^{-1} over control, respectively. Increased oil content with application of zinc might be due to its role in activating and synthesizing various enzymes which resulted in the synthesis of oil in mustard seed. Activation and biosynthesis of various enzymes possibly increase the protein content in mustard seeds, and increased seed yield resulted in increased oil and protein yield. Similar results were also observed by Kumar *et al*. (2014); Kumar *et al*. (2016) and Sharma *et al*. (2017).

A critical review of datapresented in Tables 2 and 3 indicates that application of zinc significantly influence the N, K, and Zn content and their uptake by seed and stover up to 8 kg Zn ha^{-1} over control. The phosphorus content in both seed and stover decreased with increasing rate of zinc. The highest concentration of these nutrients and their uptake by seed and stover were observed with application of 12kg Zn ha^{-1}. The N, K, and Zn content increased to an extent of 3.41, 12.62 and 26.40 percent in seed and 4.20, 9.09 and 16.09 percent in stover with application of 12kg Zn ha^{-1} over control, respectively. The reduction in phosphorus concentration as a result of zinc application might be due to the antagonistic relation of zinc with phosphorus. The zinc application might have created obstacle in absorption and translocation of phosphorus from the roots to the shoots (Reddy and Yadav, 1994). Data presented in previous chapter reveals that N, K, and Zn uptake increased by 26.75, 38.18 and 55.11 percent by seed and 25.33, 31.09 and 39.51 percent by stover under application of 12kg Zn ha^{-1} over control, respectively. Zinc is important as a structural constituent and co-factor of many enzymes concerned with protein metabolism, carbohydrate metabolism, auxin metabolism and enzymatic activities related to photosynthesis as well as respiration (Alloway, 2008). Zinc shows a positive interaction with nitrogen and potassium, increased their content and uptake by mustard seed and stover. Increased concentration of these nutrients in seed and stover also increased the total uptake of these nutrients. The results are in accordance with the findings of Kumar *et al*. (2014); Sharma *et al*. (2017) and Nayak*et al*. (2020).

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Table 1 Effect of irrigation and zinc on oil content, oil yield, protein content and protein yield

Treatments	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	Protein yield(kg ha^{-1})
Irrigation frequency				
I_1= One irrigation	39.70	721.04	21.49	390.12
I_2= Two irrigations	40.75	818.35	21.51	431.69
I_3= Three irrigations	41.23	871.08	21.53	455.13
SEm±	0.16	21.78	0.07	10.53
C.D. (P = 0.05)	0.55	75.35	NS	36.45
Zinc application				
Zn_0 = Control	40.03	696.63	21.06	365.92

Zn_4= 4kg Zn ha^{-1}	40.40	777.71	21.45	412.41
Zn_8= 8 kg Zn ha^{-1}	40.81	865.61	21.74	460.47
Zn_{12}= 12 kg Zn ha^{-1}	40.99	874.02	21.78	463.78
SEm±	0.12	10.02	0.06	5.13
C.D. (P = 0.05)	0.34	29.08	0.18	14.89

Table 2. Effect of irrigation and zinc on N, P, K, and Zn content

Treatments	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)		Zinc content (ppm)	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
Irrigation frequency								
I_1 = One irrigation	3.327	0.941	0.600	0.446	0.621	1.129	44.608	31.967
I_2 = Two irrigations	3.488	0.953	0.612	0.455	0.705	1.178	46.730	33.241
I_3 = Three irrigations	3.509	0.961	0.614	0.458	0.714	1.194	47.353	33.720
SEm±	0.011	0.004	0.003	0.003	0.005	0.009	0.249	0.225
C.D. at 0.05	NS	NS	NS	NS	NS	NS	NS	NS
Zinc application								
Zn_0 = Control	3.370	0.928	0.628	0.468	0.634	1.106	39.910	30.020
Zn_4 = 4 kg Zn ha^{-1}	3.432	0.949	0.619	0.463	0.667	1.150	44.340	32.517
Zn_8 = 8 kg Zn ha^{-1}	3.478	0.963	0.608	0.448	0.704	1.199	50.223	34.517
Zn_{12} = 12 kg Zn ha^{-1}	3.485	0.967	0.580	0.432	0.714	1.212	50.447	34.850
SEm±	0.010	0.004	0.003	0.003	0.005	0.011	0.336	0.223
C.D. at 0.05	0.029	0.012	0.009	0.009	0.015	0.032	0.974	0.648

Table 3 Effect of irrigation and zinc on N, P, K, and Zn uptake

Treatments	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})		Zinc uptake (g ha^{-1})	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
Irrigation frequency								
I_1 = One irrigation	62.42	42.24	10.97	19.92	12.20	51.81	83.99	147.07

I_2 = Two irrigations	69.07	46.09	12.19	21.94	13.73	56.54	93.65	160.08
I_3 = Three irrigations	72.82	47.18	12.87	22.46	14.55	58.03	98.64	163.83
SEm±	1.69	0.87	0.27	0.45	0.27	1.40	1.75	3.61
C.D. at 0.05	5.83	3.00	0.94	1.57	0.92	4.84	6.07	12.50
Zinc application								
Zn_0 = Control	58.55	38.97	10.91	19.69	11.00	46.70	69.30	126.18
Zn_4 = 4 kg Zn ha^{-1}	65.99	44.49	11.92	21.69	12.84	53.64	85.24	152.33
Zn_8 = 8 kg Zn ha^{-1}	73.68	48.38	12.88	22.54	14.94	60.28	106.33	173.44
Zn_{12} = 12 kg Zn ha^{-1}	74.21	48.84	12.34	21.83	15.20	61.22	107.49	176.03
SEm±	0.82	0.74	0.16	0.36	0.20	0.99	1.30	2.79
C.D. at 0.05	2.38	2.16	0.45	1.05	0.57	2.88	3.78	8.10

References:

1. Alloway, B.J. 2008. Zinc in soil and crop nutrition. IZA and IFA press, France.
2. Anonymous, 2019. Agricultural Statistics at a Glance 2018. Directorate of Economics & Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi, p. 468.
3. Aswal, Subhash and Yadav, K.K. 2007. Effect of sulphur and zinc on growth, yield, quality and net returns of mustard (*Brassica juncea* (L.) Czern and Coss). *Current Agriculture*, **31** (1-2): 127-129.
4. Chandar, S., Rawat, T.S., Lakhawat, S.S., Yadav, K.K. 2012. Effect of organic manures and biofertilizers on the yield parameters of Gladiolus cv. White prosperity. *Ecology, Environment and Conservation*, **18** (1): 91-94.
5. Garnayak, L.M., Singh, N.P., Singh, S., Paikaray, R.K. and Singh, S. 2000. Influence of irrigation and nitrogen on growth, yield and nutrient uptake by the late sown *Brassica* oilseeds.*Indian Journal of Agronomy*, **45**:371-378.
6. Kookana, R.S. Maheshwari, B., Dillon, P., Dave, S.H., Soni, P., Bohra, H., Dashora, Y., Purohit,R.C., Ward, J., Oza, S., Katara, P., Yadav, K.K., Varua, M.E., Grewal, H.S., Packham, R., Jodha, A.S. and Patel, A.K. 2016. Groundwater scarcity impact on inclusiveness and women empowerment: Insights from school absenteeism of female students in two watersheds in India, *International Journal of Inclusive Education,* 20:11, 1155-1171, DOI: 10.1080/13603116.2016.1155664

7. Kumar, M., Kumar, R., Singh, P.K., Singh, M., Yadav, K.K. and Mittal, H.K. 2015. Catchment delineation and morphometric analysis using geographical information system. *Water Science and Technology*, **72** (7): 1168–1175.
8. Kumar, V., Kandpal, B.K., Dwivedi, A., Sagar, V.K., Kumar, V. and Sharma, D.K. 2016. Effect of nitrogen and zinc fertilizer rates on growth, yield and quality of Indian mustard(*Brassica juncea* L.).*International Journal of Agriculture Sciences*, **8**: 1031-1035.
9. Kumar, V., Singh, S.K. and Suman, S.N. 2014. Zinc-boron interaction effects on yield, nutrient uptake and quality of mustard (*Brassica juncea* L.) in Ustifluvents. *RAU Journal of Research*, **24** (1-2): 59-63.
10. Machiwal, D., Singh, P.K. and Yadav, K.K. 2017. Estimating aquifer properties and distributed groundwater recharge in a hard-rock catchment of Udaipur, India. *Applied Water Science*, **7** (6): 3157-3172.
11. Mishra, J., Singh, R.K., Yadaw, D.,Nayak, J.K. and Mishra, A.P. 2019. Nutrient uptake and economics of Indian mustard [Brassica juncea L. Czernj and Cosson] as influenced by tillage and irrigation frequency. *International Journal of Chemical Studies*, **7**(1): 2123-2126.
12. Nayak, B.K., Adhikary, S., Pattnaik, M. and Pal, A.K. 2020. Effect of sulphur and zinc with combination of FYM on yield and uptake of nutrients in mustard (Brassica JunceaL.) under Alfisols of Odisha. *Journal of Pharmacognosy and Phytochemistry*, **9**(2): 2310-2313.
13. Ray, K., Sengupta, K., Pal, A.K. and Banerjee, H. 2015. Effects of sulphur fertilization on yield, Sulphur uptake and quality of Indian mustard under varied irrigation regimes. *Plant, Soil and Environment*, **61**(1): 6-10.
14. Sharma, J.K., Jat, G., Meena, R.H., Purohit, H.S. and Choudhary, R.S. 2017. Effect of vermicompost and nutrients application on soil properties, yield, uptake and quality of Indian mustard (Brassica juncea). *Annals of Plant and Soil Research*, **19**(1): 17-22.
15. Singh, D.P., Yadav, K.K. and Qureshi, F.M. 2013. Available micronutrient status, their relationship with soil physico-chemical properties and content in wheat crop of semi-arid eastern plain zone of Rajasthan. *Green Farming*, **4**: 137-142.
16. Singh, S., and Thenua, O.V.S. 2017. Effects of irrigation schedules and nutrient levels on mustard (*Brassica juncea* L.). *National Conference on Climate Change and Agricultural Production: Adapting Crops to Climate Variability and Uncertainty,* **6**: 427- 428.
17. Verma, O.P., Singh, S., Pradhan, S., Kar, G. and Rautaray, S.K. 2018. Irrigation, nitrogen and sulphur fertilization response on productivity, water use efficiency and quality of ethiopian mustard (*Brassica carinata*) in a semi-arid environment. *Journal of Applied and Natural Science*, **10** (2): 593-600.

18. Yadav, K.K. and Singh, P.K. 2018. Prioritization for Management of Groundwater Quality-Related Problems of Rajsamand District of Rajasthan. In: V. P. Singh et al. (eds.), Groundwater, *Water Science and Technology Library***76**, 211-227. https://doi.org/10.1007/978-981-10-5789-2_16

19. Yadav, K.K., Meena, M.K. and Mali, N.L. 2021. Impact of graded levels of fertility and biofertilizers on yield attributes and yield of mungbean [Vignaradiata (L.) Wilczek]. *International Research Journal of Humanities and Interdisciplinary Studies*, **2** (6): 280-289.