Biological Forum – An International Journal **14(3): 1540-1545(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Response of Select Mustard (*Brassica juncea* L.) Varieties to varying Irrigation Schedules based on IW/CPE Ratio

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(Received 19 July 2022, Accepted 29 August, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The experimental trial conducted at research farm (Agronomy) of Pacific College of Agriculture, Udaipur, during the *rabi* season of 2018–19, a field experiment named "Response of select mustard (*Brassica juncea* L.) cultivars to varied irrigation schedules based on IW/CPE ratios" was carried out. The experiment was set up using a factorial randomized block design with three replications. The treatment included a mix of six types (PM-26, RH-749, RH-406, Pusa30, Girraj, and Bio 902) and three irrigation schedules (0.40, 0.60, and 0.80 IW/CPE ratio) placed in the main plot, resulting in eighteen treatment combinations. The findings demonstrated that types Bio 902 and Girraj considerably outgrew the other test kinds in terms of plant height. The variety Girraj generated noticeably the most main branches per plant, green leaves per plant, siliquae per plants, and seeds per siliqua. Girraj had a greater mean seed yield than the other types at 25.51 q ha^{-1}. Over the other kinds, the Girraj variant has the highest oil content. In comparison to irrigation at IW/CPE ratios of 0.4 and 0.6, irrigation at IW/CPE ratio 0.8 considerably increased plant height at maturity, the number of green leaves per plant, and the number of branches per plant. Significant increase in the quantity of siliquae and seeds per plant. The highest seed production of 20.33 q ha^{-1} was recorded with an IW/CPE ratio of 0.8 as opposed to 0.4. Compared to IW/CPE ratios 0.4 and 0.6, irrigation at an IW/CPE ratio of 0.8 produced the oil content that was by far the greatest.

Keywords: Variety, Irrigation, Treatment, Replication, Combination, Yield and oil Content.

INTRODUCTION

The global output of 11.12%, India is the third-largest producer of mustard behind China and Canada (Rapeseed & Mustard Statistics 2019-20, DRMR, Bharatpur)* Mustard, one of the seven edible oilseeds grown in India, provides 28.6% of the country's total oilseed output, coming in second to soybean, which accounts for 91.16 percent of the oilseed industry (F. A. O 2019-20). It is mostly grown in Rajasthan, Uttar Pradesh, Haryana, and Madhya Pradesh in India, which together account for 81.5% of the country's land and 87.5% of its output (2018–19). Rajasthan alone accounts for 47.22% of this production.

Oils are considered essential food items for a wholesome diet. Most of the oilseeds contain vegetable oil, proteins, minerals and vitamins. Besides the daily used commodity in every household, oilseed have numerous industrial uses like manufacture of soaps, paints, varnishes etc. Oil meals obtained from oilseeds are used as cattle feed, as a rich source of proteins.

The low productivity of oilseeds, extraordinary population growth, and increased demand for edible oils cause a spike in oil costs that are beyond of the grasp of the average person. In contrast to the minimal daily need of 18 g recommended by the F.A.O, our country only provides 12 g of oils and fats per person. The typical person should consume 14 kilograms per capita year, according to the Indian Council of Medical Research.

It is an annual herbaceous plant and it belongs to the Brassicaceae family. It may grow in light (sandy), medium (loamy), and heavy (clay) soil types, although it favours well-drained ground. It can grow both in extremely acidic and alkaline soils. Mustard seeds have an oil content that ranges from 37 to 49%. The seed and oil are used to pickles as a condiment and are also used to season vegetables and curries. In northern India, the

oil is used for frying and cooking that is intended for human consumption. Feed and manure are made from the oil cake. Green feed for cattle may be found in green stems and leaves. Young plants leaves are consumed as a green vegetable because they contain minerals and sulphur, which are essential nutrients.

In order to increase yield and improve mustard quality, varieties are crucial. There is a significant disparity in the meteorological and edaphic conditions present in mustard-growing regions in India. It has become essential to evaluate the potential of the cultivars under various irrigation schedules as a result of the creation of new mustard cultivars in a climate that is changing. Many new kinds with good yields and gentle responses to varying irrigation levels have been published by research institutions. According to Bora (2012), because to their innate capacity, different mustard genotypes may have varying yield potential under various agro-climatic situations. The crop's low yield is caused by the usage of native types and moisture stress at crucial phases. It is vital to assess their capacity for production in light of the introduction of new mustard.

Agriculture output depends heavily on irrigation. An ideal irrigation schedule is important for making optimum use of the water resources available and increasing crop output. Due to inadequate water supplies and erroneous irrigation timing, crop yield and quality frequently decrease. It is important to use available irrigation water in a way that corresponds to the crop's water requirements.

The crop's water requirements vary dramatically throughout the growing season due to variations in crop canopy and weather conditions. Traditional irrigation scheduling aimed to keep soil moisture levels near to the field's capacity while delivering an appropriate water flow for output. Crop irrigation requirements differ based on the crop, the amount of moisture held in the soil profile, and the local weather.

Irrigation is a vital component in agricultural production. Optimum schedule of irrigation assumes significance in efficient use of limited water for higher yield. Yield and quality of crop often suffers due to deficient water supply and improper scheduling of irrigation. Accessible irrigation water needs to be utilized in a manner that matches the water needs of the crop. Water requirements of the crop vary substantially during the growing period due to variation in crop canopy and climatic conditions. Irrigation scheduling has conventionally aimed to achieve an optimum water supply for productivity, with soil water content being maintained close to field capacity. Irrigation requirement of crop varies with crop condition, moisture storage in the soil profile and prevailing weather condition of the area. There are several reports which indicate that irrigation increased the production of mustard. Raut *et al.* (2007) reported that about 33% increase in yield with the application of two irrigation at pre-flowering and pod filling stages. The production of edible oil may be increased by applying irrigation at proper scheduling as this crop is grown in *rabi* season under rainfed condition.

MATERIAL AND METHODS

During the 2018-19 *rabi* season, a field experiment titled "Response of select mustard (*Brassica juncea* L. Czern) cultivars under varying irrigation regimens" was conducted in line with the **IW/CPE ratio**. The experiment was carried out at the Pacific College of Agriculture's Instructional Farm (Agronomy), which is located at 24°-34' N latitude and 73°-42' E longitude, at an altitude of 582.17 metres above mean sea level. It is located in Rajasthan's agro-climatic zone IVa "Sub-humid southern plains and the Aravalli Hills area," with maximum and lowest relative humidity ranging from 46.0 to 92.1 and 7.7 to 80.1%, respectively. During the crop season, 29.4 mm of rainfall.

Treatments and experimental design. Eighteen distinct treatment combinations, including varieties PM 26, RH 749, RH 406, Pusa 30, Girraj, and Bio 902 six kinds of *Brassica juncea* L. breeder seeds. In factorial RBD with three replications, the Indian Institute of Rapeseed and Mustard, Bharatpur (Rajasthan), and three levels of irrigation (0.40, 0.60, and 0.80) were examined.

Details of Experiment	
Location	The experiment was carried out on the farm of the Pacific College of Agriculture in Udaipur.
Crop	**Mustard (*Brassica juncea*)**
Season	***Rabi* 2018-19**
Experimental Design	Factorial RBD
Variety	06
No. of Treatment	6×3=18
No. of Replication	03
Total No. of Plots	54
Irrigation Levels	03
Plot Size	1.5 m × 1.2 m

Irrigation: Irrigation was supplied based on the treatment's IW/CPE ratios of 0.4, 0.6, and 0.8. Each irrigation used 60 mm of water.

Study of Parameters:

Plant height: The height of five randomly selected plants from each plot was measured at 60 and 90 DAS and at harvest from the base of the plant to the fully open leaf tip, and the average was computed and expressed as height in cm.

Number of branches plant^{-1}: The principal branches of five tagged plants in each plot were counted at 60, 90, and harvest. Only productive branches per plant were examined.

Number of green leaves plant^{-1}: The five plants already tagged in each plot were used to count the number of green/photosynthetically active leaves at three phases of development (60, 90 and at harvest).

Number of siliquae plant^{-1}: The total number of siliquae in each plant sample was counted, and the average number of siliquae plant-1 was computed.

Number of seeds siliqua^{-1}: The seeds of twenty-five siliquae from each plot's tagged plants were counted. To determine the number of seeds siliqua-1, the mean number of seeds was determined.

Seed yield (q ha^{-1}): The entire dry matter from each plot was manually threshed, winnowed, and cleaned. The crop was sun dried and weighted plot by plot on a precision balance, and the yield was transferred to kilograms per hectare (kg ha-1).

Oil content: The oil content of the seed was evaluated using Soxhlet's oil extraction technique (Sadasivam and Manikam 1922).

$$\text{Oil content (\%)} = \frac{\text{Weight of flask with oil weight of empty flask}}{\text{Weight of sample taken}} \times 100$$

RESULTS

In present investigation, a significant difference has been observed among all the treatments and presented in table1.

Plant height: Variety Bio 902 had the greatest plant height at maturity, which was determined to be on par with variety Girrraj, and both of these varieties had much larger plant height than the other types. The mean findings show that variety Bio 902 produced 3.48,3.16,1.78,2.51 and 0.35 percent more plant height than other kinds. Increasing the IW/CPE ratio from 0.4 to 0.8 boosted plant height considerably at each development stage. The mean data reveal that the maximum plant height was recorded at maturity with irrigation at IW/CPE ratio 0.8, which delivered higher plant height by 6.7 and 3.20 percent above irrigation at IW/CPE ratio 0.4 and 0.6 ratio, respectively.

Number of branches plant^{-1}: Variety Girraj generated the most branches plant-1 at maturity, which was comparable to variety Bio 902, and both of these cultivars recorded considerably more branches plant^{-1} than the other kinds. The mean statistics show that variety Girraj produced 3.04, 2.98, 2.07, 2.30, and 1.01 percent more branches plant^{-1} than other kinds. The mean results reveal that the maximum number of branches plant^{-1} was recorded at maturity with irrigation at IW/CPE ratio 0.8, which gave a larger number of branches plant^{-1} by 6.23 and 3.50 percent over irrigation at IW/CPE ratio 0.4 and 0.6 ratio, respectively.

Number of green leaves plant^{-1}: Girraj variety has the largest number of green leaves plant^{-1}. According to the mean statistics, variety Girraj produced 1.49,1.40,0.51,0.53 and 0.34 percent more green leaves plant^{-1} than types PM26, RH-406, RH749.Pusa 30, and Bio 902. The mean data reveal that irrigation at IW/CPE ratio 0.8 produced considerably more green leaves plant^{-1} than irrigation at IW/CPE ratios 0.4 and 0.6, respectively, by 3.20 and 3.29 percent.

Number of siliquae plant^{-1}: Girraj had the largest number of siliquae plant^{-1}. The mean statistics show that variety Girraj produced 5.9,5.5,7.0,8.4 and 4.24 percent more siliquae plant^{-1} than varieties PM26, RH-406, RH749. Pusa 30 and Bio 902, respectively. Increasing the IW/CPE ratio from 0.4 to 0.8 greatly increased the number of siliquae plant^{-1}. The mean findings demonstrate that irrigation at IW/CPE ratio 0.8 produced considerably more siliquae plant^{-1} than irrigation at IW/CPE ratios 0.4 and 0.6, respectively.

Number of seeds siliquae^{-1}: Variety Girraj recorded significantly the highest number of seeds siliquae^{-1}. The mean data indicate that variety Girrajgave 2.75,2.57,2.14,1.19 and 0.42 per cent higher number of seeds siliqua^{-1} over varieties PM 26, RH-749, RH-406, Pusa 30 and Bio 902 respectively. The average results show that irrigation with an IW/CPE ratio of 0.8 generated significantly more siliquae plant^{-1} than irrigation with ratios of 0.4 and 0.6, respectively. The mean findings reveal that irrigation at IW/CPE ratio 0.8 produced considerably more seeds per siliquae than irrigation at IW/CPE ratios 0.4 and 0.6, respectively.

Seed yield: Data show that the variety Girraj provided the maximum seed production. The mean statistics reveal that variety Girraj produced 60.95,31.26,45.77,35.8 and 32.47 percent more seed than varieties PM26, RH-749, RH-406. Pusa 30, and Bio 902, respectively. Irrigation with an IW/CPE ratio of 0.8 yielded substantially more seed than irrigation with an IW/CPE ratio of 0.4, and the former level was found to be on par with irrigation with an IW/CPE ratio of 0.6. The mean results show that irrigation at IW/CPE ratio 0.8 increased seed production by 4.47 and 4.20

percent above irrigation at IW/CPE ratios 0.4 and 0.6, respectively.

Oil content (%): Data show that variety Girraj had the greatest oil content in seed when compared to other varieties, but was on level with variety Bio 902. The mean data shows that the variety Girraj has the maximum oil content in seed (40.33), with all other types being equal. Irrigation at varied IW/CPE ratios ranging from 0.4 to 0.8 had a substantial impact on crop oil content as the number of irrigations increased.

Table 1: Effects of Different Mustard Crop Varieties and Irrigation Schedules on Growth Characteristics, Yield, and Yield Attributes.

Varieties	Plant height (cm)	Number of branches plant^{-1}	Number of green leaves plant^{-1}	Number of siliquae plant^{-1}	Number of seeds siliqua	Seed yield (q ha^{-1})	Oil content (%)
PM 26	152.444	13.644	24.333	176.022	11.067	15.85	38.43
RH 749	153.444	13.711	24.622	176.711	11.222	19.41	39.99
RH-406	155.556	14.800	23.667	174.111	11.622	17.50	39.77
Pusa 30	156.444	14.467	24.378	178.845	12.600	18.78	39.22
Girraj	157.778	17.800	25.578	186.444	14.111	25.51	40.33
Bio 902	158.333	16.156	24.578	184.756	13.533	21.55	39.55
S.Em(±)	**0.316**	**1.528**	**0.123**	**0.418**	**0.078**	**4.614**	**15.05**
C.D	**0.912**	**0.247**	**0.356**	**1.207**	**0.225**	**13.318**	**N/A**
Irrigation scheduling							
0.40	150.722	12.033	22.889	164.544	8.878	19.46	39.05
0.60	155.889	14.256	24.722	178.511	10.600	19.51	43.13
0.80	160.889	19.256	25.967	195.389	17.600	20.33	39.97
S.Em(±)	**0.223**	**1.081**	**0.087**	**0.296**	**0.055**	**3.263**	**10.64**
C.D	**0.645**	**3.119**	**0.214**	**0.159**	**0.159**	**9.417**	**N/A**

DISCUSSIONS

Many significant variations in the criteria used for treatment evaluation were obtained under the influence of different treatments while presenting the results of a field experiment titled "Response of select mustard (*Brassica juncea* L.) varieties under varying irrigation schedules based on IW/CPE ratio" in the preceeding chapter. This chapter discusses substantial variations or those assuming consistent trends. The current investigation's findings have been used to try to construct a cause-and-effect link, which has been backed by accessible data and related literature.

Varieties Impact on Growth and Yield Parameters. The results showed that variety Bio 902 had the maximum plant height at 90 DAS and at maturity (Table 1). The diversity in growth characteristics might be related to changes in the genetic constitution of various varieties, as well as the presence of genotype and environment interactions, which play a key role in variety phenotypic performance. Girraj looks to be a more robust grower as compared to other types. Girraj had the most number of branches per plant. Thus, a greater number of branches per plant might be ascribed to considerably greater plant height at 90 DAS and at maturity when compared to other kinds. This claim may be supported by the observation of a strong and positive association between plant height and number of branches per plant (0.959). Several workers have documented variety heterogeneity in plant height and number of branches per plant (Chauhan *et al*., 2002; Mehrota *et al*., 2004).

The results showed that variety Girraj had a much larger quantity of siliquae per plant and seeds per siliqua than the other test types (Table 1). This trend in yield attributes might be attributed to the better intrinsic ability of variety Girraj for partitioning dry matter toward the production of reproductive organs, which could have resulted in a higher number of green leaves per plant and a higher number of siliquae per plant. In the current study, it appears that the number of siliquae per plant was determined by the amount of green leaves per plant. This claim might be supported by the observation of a strong and positive association between the number of green leaves per plant and the number of siliquae per plant (0.738). Several researchers, notably Reddy and Kumar (2007) have documented significant variability in yield contributing factors such as number of siliquae per plant and seeds per siliqua (2011).

The results showed that the variety Girraj yielded substantially more than the other types. Varieties production trends might be related to differences in the amount of green leaves per plant at 90 DAS. The assertion is further supported by a significant and positive association between yield and the number of green leaves per plant (0.985). Trivedi *et al*. (2016); Parihar *et al.* (2011) both showed significant variability in yield (2014). The fact that variety Girraj has much larger biological yields than other types might be attributable to their various trends in seeds and yield. Correlation studies show a substantial and positive relationship between biological yield and seed yield (0.968) as well as biological yield and stover yield, lending weight to the aforementioned thesis. These

findings are comparable to those of Meena and Sumeriya (2014).

In the current study, the types Girraj and Bio 902 had considerably greater oil content than the other kinds (Table 1). This trend in oil content might be attributed mostly to genetic heterogeneity across oil content variants. Bharadwaj and Singh (2012); Kumar *et al.* (2014) both showed significant variability in oil content (2013).

Irrigation's Influence on Growth and Yield Parameters. The results showed that irrigation with a 0.8 IW/CPE ratio resulted in considerably higher plant height at 90 DAS and at maturity. (Table 1).

At an irrigation intensity of 0.8 IW/CPE ratio, a substantial increase in plant height and number of branches per plant was seen at 90 DAS and at maturity. Thus, a large increase in the number of branches per plant might be attributed to increased plant height as a result of regular watering. This claim might be supported by the observation of a strong and positive association between plant height and number of branches per plant (0.975). These findings are consistent with the findings of Meena and Sumeriya (2014), who discovered a substantial increase in plant height with irrigation at 0.8 IW/CPE ratio over 0.4 IW/CPE ratio.

In the present investigation, significant increase in plant height and number of branches per plant at 90 DAS and at maturity were observed at irrigation level of 0.8 IW/CPE ratio. Thus, significant increase in number of branches per plant could be ascribed to better plant height due to frequent irrigation. This contention could be justified by observance at significant and positive correlation between plant height and number of branches per plant (0.975). These results are in close conformity with the findings of Meena and Sumeriya Sumeriya (2014) who observed significant increase in plant height with irrigation at 0.8 IW/CPE ratio over 0.4 IW/CPE ratio.

A significant increase in the number of siliquae per plant was found when the watering frequency was increased from 0.6 to 0.8 IW/CPE ratio (Table 1). An increase in the number of siliquae per plant at higher IW/CPE ratios might be attributed to improved vegetative development of plants, as evidenced by a substantial rise in the number of branches at higher IW/CPE ratios in the current study. This claim might be supported by the observation of a substantial and positive association between the number of branches and the number of siliquae per plant (0.952). Samui *et al.* (2012) also observed the greatest number of branches at 0.80 IW/CPE ratio.

The results revealed a considerable increase in the number of seeds per siliqua with irrigation at 0.6 to 0.8 IW/CPE ratio over 0.4 IW/CPE ratio. This increased number of seeds per siliqua at higher IW/CPE ratios might be attributed in part to greater green leaves due to appropriate soil moisture availability. This claim is supported by the discovery of a strong and positive association between the number of green leaves and the quantity of seeds per siliqua (0.829). The availability of appropriate soil moisture during blooming under higher IW/CPE ratios may have also resulted in an increase in the number of seeds per siliqua. These data support Shyamraj and Yashwant (2012) recommendation of one irrigation during blooming to yield 20% more siliqua.

Irrigation yielded the highest seed production at an IW/CPE ratio of 0.8. The most likely cause for higher output under this IW/CPE ratio was adequate soil moisture accessible to crop plants. Yadav and Yadav (1999); Panda *et al.* (2000); Chauhan *et al*. 2002; Piri and Sharma (2007).

The quality of mustard seed was assessed using oil output, which was greatly impacted by irrigation. Irrigation had a negative effect on seed oil content under two irrigations, one at blooming and one at siliquae development. It is likely that a sufficient supply of moisture aids in nutrient absorption. These findings are similar to those of Tomar *et al.* (1992); Singh *et al*. (1994). Irrigation considerably increases oil yield because oil yield is a function of seed yield; hence, irrigation significantly increases oil output.

CONCLUSION

According to the findings of a field experiment titled "Response of various mustard varieties (*Brassica juncea* L.) under varied irrigation regimens depending on IW/CPE ratio" conducted during the 2018-19 rabi season, It can be concluded that using the mustard variety Girraj and applying irrigation at an IW/CPE ratio of 0.8 appears to be favourable for this agro-climatic zone IV A, since this treatment combination Girraj0.8 IW/CPE ratio produced the maximum seed yield of 26.95 q ha^{-1}.

FUTURE SCOPE

Mustard was best cultivated in an environmentally friendly manner with several cultivars such as PM-26, RH-749, RH-406, Pusa 30, Girraj, and Bio 902 under variable irrigation schedules of 0.40, 0.60, and 0.80 IW/CPE ratio. In terms of mustard growth and development, all types and watering schedules assist farmers

Acknowledgement. Regards and thanks are extended to Dr. G.L. Sharma, Associate Professor (Major Advisor) in the Department of Agronomy, Respected committee members and my dearest friends and seniors for the wise direction, encouragement, and helpful criticism throughout the research and manuscript-writing process.

Conflict of Interest. None.

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How to cite this article: Shristi Singh, Deepak Kumar, Bhawana and G.L. Sharma (2022). Response of Select Mustard (*Brassica juncea* L.) Varieties to varying Irrigation Schedules based on IW/CPE Ratio. *Biological Forum – An International Journal, 14*(3): 1540-1545.