Biological Forum – An International Journal 14(4): 244-247(2022)

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

Influence of Irrigation Scheduling on Productivity of Wheat + Mustard Intercropping System

Jitendra Sisodiya, P.B. Sharma, Badal Verma, Muskan Porwal, Mahendra Anjna and Rahul Yadav*
Department of Agronomy, College of Agriculture,
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh), India.

(Corresponding author: Badal Verma)*
(Received 18 August 2022, Accepted 28 September, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The water resources are rapidly declining due to nominal recharging by rainfalls. Thus, the water applied through irrigation should focus on its judicious use by utilizing every drop of water. However, irrigation at a suitable IW/CPE ratio in cereal legume intercropping systems can improve the system's productivity in addition to proficient use of water. Therefore, a field experiment was conducted at Instructional Research Farm, Krishi Nagar, Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *Rabi* season 2020-21 to study the effect of irrigation scheduling on different intercropping practices. The experiment was laid out in a split-plot design with fifteen treatment combinations and replicated thrice. The results revealed that, among the irrigation scheduling, different parameters, *i.e.*, plant height, dry matter production, and also grain and seed yield, were recorded higher in irrigation scheduling of 1.0 Irrigation water/Cumulative pan evaporation ratio and most suitable for the wheat + mustard intercropping system after that 0.8 IW/CPE ratio and lower in scheduling irrigation at 0.6 IW/CPE ratio. Among intercropping practices, sole wheat and mustard recorded higher crop growth parameters and yield. IW/CPE of 0.6 with an 8:2 row ratio gives higher LER and is most suitable for wheat + mustard intercropping system.

Keywords: Irrigation scheduling, IW/CPE ratio, LER, Wheat + mustard intercropping.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the world's most important staple crops, with over 2.5 billion people eating it in 89 countries. Wheat is grown on a total of 31.45 million hectares in India, with a production of 107.60 million tonnes and productivity of 3420 kg/ha (USDA, 2020). It is farmed on 10.02 million hectares in Madhya Pradesh, with a total production of 16.92 million tonnes and productivity of 3298 kg/ha (Anonymous, 2020).

Worldwide, rapeseed and mustard are grown on 36.59 million hectares, producing 72.37 million tonnes, with a productivity of 1980 kg/ha in 2018–19. India is responsible for 9.8% of global production and 19.8% of the global land area (USDA, 2018). 8.6 million tonnes of rapeseed and mustard are produced in India on 6.23 million hectares, yielding 1346 kg/ha (DRMR, 2019). Rapeseed – mustard crops in India are grown in diverse agro climatic conditions ranging from north-eastern /north –western hills to down south under irrigated /rainfed timely/late sown, saline and mixed cropping (Gupta *et al*., 2020). Indian mustard (*Brassica juncea* L.), accounts for more than 90% of the total mustard area grown in India out of rapeseed-mustard.

In general, because the need for land for other sectors will continue to rise, there is little opportunity to bring additional areas entirely under pulses, oilseeds, or even wheat. As a result, the only option is to increase crop productivity. Intercropped oilseeds and pulses may be a more efficient use of resources than a single crop for enhancing productivity and profitability. Intercrops are less sensitive to pests and diseases, and they may be highly effective at suppressing weeds, resulting in better yields and profits (Singh *et al*., 2010). Mustard is India's most important oilseed crop, whereas wheat is the most demanded food grain crop. These crops are primarily grown in irrigated conditions during winter in a wide range of soils and climates (Pimpale *et al*., 2015). Thus, their intercropping can prove feasible and profitable.

Soil moisture is the most limiting factor for crop cultivation. Due to the scarcity and unavailability of irrigation water, production of mustard and wheat is lower than average productivity of the country (Kullu *et al*., 2018). To make the best use of irrigation water, it is essential to understand the proper irrigation timing and irrigation volume. Surface irrigation techniques are used to irrigate *rabi* crops; however, because of higher non-beneficial evapotranspiration, irrigation efficiency can be as low as 30–40% (Rajanna *et al*., 2016). Improved irrigation practices combined with routine watering increase the amount of soil moisture in the rhizosphere, encouraging cellular growth, stomatal conductance, and photosynthetic activity (Rana *et al*., 2019). Additionally, it improves the availability of specific nutrients to agricultural plants (Verma *et al*., 2018). Over 40% of the wheat in developing countries is produced using irrigated systems (Rajaram *et al*., 2007). Deficit irrigation generally impacts wheat yield and water use efficiency (Galavi & Moghaddam 2012). The timing of irrigation is also essential for water management. Irrigation failure at some critical growth stages drastically reduces grain yield (Kumar *et al*., 2014) due to lower test weight. Rosette, pre-flowering and pod development are three crucial mustard growth stages that require irrigation. Two irrigations applied to mustard at the pre-flowering + grain filling stages considerably improve growth and yield-related characteristics (Singh *et al*., 2018). The most crucial choice for boosting water production in a stressful environment will be appropriate water management with irrigation scheduling based on a critical growth stage approach (Rizk & Sherif 2014). Thus, irrigation scheduling provides guidance and information to the farmers to develop irrigation strategies for each plot of the field on the farm. Keeping these points in view experiment was conducted to find out the effect of the IW/CPE ratio on the productivity of the wheat + mustard intercropping system.

MATERIALS AND METHODS

A field experiment was conducted at Instructional Research Farm, Krishi Nagar, Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *Rabi* 2020-21. The experiment was carried out in a split-plot design with three replications. The main plot treatments are IW/CPE ratio 1.0, IW/CPE ratio 0.8, and IW/CPE ratio 0.6, and subplots had five treatments Sole wheat, Sole mustard, Wheat + mustard (4:2 ratio), Wheat + mustard (6:2 ratio) and Wheat + mustard (8:2 ratio). The soil of the experimental field was sandy clay loam in texture, medium in organic carbon (0.60 %), available nitrogen (281.4 kg/ha), available phosphorus (20.3 kg/ha), and available potassium (272.1 kg/ha). It was neutral in the soil reaction (pH 6.7). The wheat variety JW 3288 and mustard variety Pusa Agrani were sown manually on 29 November 2020. Seeds were planted in the rows using the seed rate of 100 kg/ha for wheat and 5 kg/ha for mustard. Sowing was done in the row 20 cm for sole wheat, and mustard 40 cm with intercropping of wheat + mustard was 20 cm under replacement series at a depth of 3-5 cm. The entire quantity of P and K fertilizers was applied in basal as a single dose, whereas N fertilizer was used in three splits. The irrigation under different treatments was given a 5 cm depth at each. The irrigation water was measured by the coordinate method. The observations on growth parameters, grain and seed yield were noted and LER (Land equivalent ratio) was worked out. The data for various treatment effects were statistically analysed as per the procedure described by Gomez and Gomez (1984). The critical differences were calculated to assess the significance of treatment means wherever the "F" test was found significant at a 5 per cent level of significance.

RESULTS AND DISCUSSION

Plant height. The data on plant height at 60 DAS is presented in Table 1. Irrigation schedules have significantly affected the plant height of wheat and mustard. The plant height of wheat and mustard was increased significantly while increasing irrigation levels. Maximum plant height of wheat and mustard was observed under 1.0 IW/CPE ratio (72.74 cm and 136.42 cm) followed by 0.8 IW/CPE ratio, which could be due to sufficient available moisture under these treatments and minimum height was observed in 0.6 IW/CPE ratio. In the case of intercropping, the maximum plant height of wheat and mustard was observed in sole wheat (70.17 cm) and sole mustard (141.78 cm), which was at par with the 8:2 row ratio of wheat + mustard and 6:2 row ratio of wheat + mustard. It may be due to the shade effect and competition by mustard on wheat growth under narrow row ratios. This is in accordance with the findings of Barick *et al*. (2020); Alam *et al*. (2022).

Dry Matter Production (DMP). The data on above-ground dry matter production per plant of wheat and mustard at 60 DAS are presented in Table 1. Dry matter production of wheat and mustard was found to increase significantly with increasing the levels of irrigation. Maximum dry matter production of wheat and mustard was observed under 1.0 IW/CPE ratio (24.65 g/plant and 19.32 g/plant) followed by 0.8 IW/CPE ratio and minimum under 0.6 IW/CPE ratio (15.02 g/plant and 13.20 g/plant). Higher DMP might be due to frequent irrigation, leading to higher nutrient and water uptake, lower transpiration rate and regular gas exchange, ultimately resulting in higher photosynthates and their translocation to sink. In the case of intercropping, the maximum dry matter production was observed in sole wheat (21.51 g/plant) and sole mustard (18.50 g/plant). It may be due to more space than other planting patterns with sufficient sunlight. Similar findings were reported by Tripathi *et al*. (2016); Bindhani *et al*. (2020); Maurya *et al*. (2022).

Grain and seed yield. The data on the grain yield of wheat and the seed yield of mustard are given in Table 1. It was observed that wheat produced significantly higher grain yield (3215 kg/ha) under 1.0 IW/CPE ratio compared to 0.8 IW/CPE ratio and 0.6 IW/CPE ratio. Among the intercrop practices, the grain yield of sole wheat was significantly maximum (3426 kg/ha) followed by a wider row ratio of 8:2, which was further decreased with the narrowing of the ratio, *i.e*., 6:2 and 4:2. This may be due to better vegetative growth coupled with higher yield attributes resulted in higher grain yield as compare to 6:2 and 4:2 row ratio.

The seed yield of mustard was maximum with irrigation at 1.0 IW/CPE ratio (1326 kg/ha) followed by 0.8 IW/CPE ratio. The minimum seed yield was observed under the 0.6 IW/CPE ratio. In the intercropping system, sole mustard recorded a significantly maximum seed yield of 1428 kg/ha, followed by a 4:2 row ratio, and minimum mustard yield was noted in the 8:2 row ratio. This was in harmony with the findings of Singh *et al*. (2018); Pal *et al*. (2020); Maurya *et al.* (2022).

Land Equivalent Ratio (LER). The land equivalent ratio denotes the relative land area under sole cropping required to produce the exact yield as obtained under an intercropping system at the same management levels. The data on LER is shown in Fig 1. It was observed that LER was significantly affected by different IW/CPE ratios as well as the row ratio of intercropping. The land equivalent ratio was found to reduce with a higher level of irrigation; recorded maximum under 0.6 IW/CPE ratio (1.52) followed by 0.8 IW/CPE ratio and 1.0 IW/CPE ratio.

Wheat + mustard 8:2 gave the highest LER (1.78), which was at par with wheat + mustard 6:2 and significantly superior to other row ratios of intercropping systems and sole crops. The treatment combination 0.6 IW/CPE ratio with wheat + mustard 8:2 gave the highest LER (1.92). While minimum LER was observed under 0.8 IW/CPE ratio with wheat + mustard 4:2. This might be due to intercropping system obtaining a higher yield and its market price coupled with better utilization of the agronomic resources more effectively and efficiently towards increased production. Similar results were reported by Ebrahimi *et al*. (2017); Biswas *et al*. (2019).

Table 1: Influence of Irrigation scheduling and intercropping on growth parameters and yield.

Treatment	Plant height (Cm)		Dry Matter Production (Kg/ha)		Grain/Seed yield (kg/ha)	
	Wheat	Mustard	Wheat	Mustard	Wheat	Mustard
Main plot : Irrigation schedule						
IW/CPE ratio 1.0	72.74	136.42	24.65	19.32	3215	1326
IW/CPE ratio 0.8	67.70	131.42	21.71	15.78	2989	1236
IW/CPE ratio 0.6	63.37	126.67	15.02	13.20	2595	1104
SEm (±)	0.40	0.52	0.38	1.13	26	19
CD (at 5%)	1.12	1.44	1.06	3.13	72	53
Sub plot : Intercropping						
Sole wheat	70.17	-	21.51	-	3426	-
Sole mustard	-	141.78	-	18.50	-	1428
Wheat + mustard (4:2)	65.14	128.11	19.53	16.35	2500	1208
Wheat + mustard (6:2)	67.29	127.67	20.09	15.48	2755	1135
Wheat + mustard (8:2)	69.14	126.44	20.72	14.73	3051	1116
SEm (±)	1.64	1.51	0.71	2.00	57	36
CD (at 5%)	3.44	3.17	1.49	NS	121	75

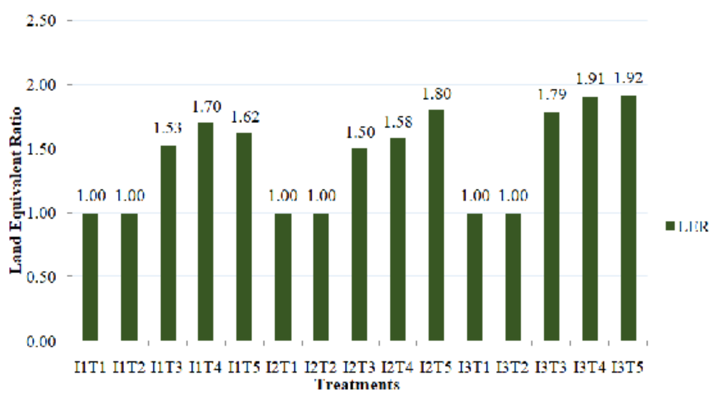

Fig. 1. Effect of Irrigation scheduling and intercropping on Land Equivalent Ratio.

CONCLUSION

Results of the present study revealed that the irrigation schedule at IW/CPE 1.0 is more suitable for the wheat + mustard intercropping system due to the more productive and profitable, and harmonious interaction of IW/CPE 0.6 with 8:2 row ratio gives higher LER (1.92) was significantly superior to rest of other treatments.

FUTURE SCOPE

This study can be beneficial for the farmers to schedule irrigation for the wheat and mustard intercropping system. However, the present investigation needs 2-3 years to be disseminated as a new profitable practice.

Acknowledgements. I extend my sincere thanks to Dr P.B. Sharma (major advisor) and to my advisory committee members for giving me proper guidance throughout the course of study and thankful to College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP) for providing facilities to carry out this work.

Conflicts of Interest. None.

REFERENCES

Alam, Mohd Shah, Naresh, R. K., Vivek, Kumar, Satendra and Singh, H. L. (2022). Effect of Sowing Methods and Irrigation Scheduling on Production and

Productivity of Wheat Crop. *Biological Forum – An International Journal*, *14*(2a): 445-452.

Anonymous (2020). Annual Report 2020-2021, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of Madhya Pradesh.

Barick, B. B., Patra, B. C., and Bandhyopadhyay, P. (2020). Performance of rapeseed under varied irrigation and sowing methods. *Journals of Crop and Weed science*, *16*(2): 269-273.

Bindhani, Debashis, Goswami, S. B., Kumar, Amit, Verma, Gaurav and Behera, Pratishruti (2020). Growth, Yield attributes and Yield of Indian Mustard [*Brassica juncea* (L.) Czern & Coss] as Influenced by Irrigation and Nitrogen Levels. *International Journal of Current Microbiology and Applied Sciences*, *9*(07): 1735-1746.

Biswas, P. K., Chakma, H. and Roy, T. K. (2019). Production potential and competitive indices of mustard-based intercropping with wheat under different row ratios.*Bangladesh Journal of Agronomy*, *22*(2): 161-169.

DRMR (2019). Directorate of Rapeseed-Mustard Research, Bharatpur, Rajsthan; 2019.

Ebrahimi, E., Kaul, H. P., Neugschwandtner, R. W. and Dabbagh, Mohammadi Nassab A. (2017). Productivity of wheat (*Triticum aestivum* L.) intercropped with rapeseed (*Brassica napus* L.). *Canadian Journal of Plant Science*, *97*: 557–568.

Galavi, M. and Moghaddam, H. A. (2012). Influence of deficit irrigation during growth stages on water use efficiency (WUE) and production of wheat cultivars under field conditions. *International Research Journal of Applied and Basic Sciences*, *3*(10): 2071–2078.

Gomez, K., and Gomez, A. (1984).Statistical Procedures for Agriculture Research. A Wiley-Inter Science Publication: John Wiley and Sons, Inc., New York, USA.

Gupta, B. K., Singh, V., Singh, B. K., Singh, N. and Mishra, B. P. (2020). Impact Analysis of Front Line Demonstrations on Yield and Economics of Mustard Crop in Banda District of Bundelkhand, Uttar Pradesh, India. *International Journal of Current Microbiology and Applied Sciences, 9*(9): 1251-1258.

Kullu, N. P., Job, M., Rusia, D. K., Rai, P. and Dubey, A. (2018). Comparative study of irrigation scheduling for mustard crop using climatological method and CROPWAT model. *International Journal of Current Microbiology and Applied Sciences, 8*(12): 1575-1582.

Kumar, P., Sarangi, A., Singh, D. K. and Parihar, S. S. (2014). Wheat Performance as influenced by Saline Irrigation Regimes and Cultivars. *Journal of Agri Search*, *1*(2): 66-72.

Maurya, Shravan Kumar, Kalhapure, Aniket, Singh, Narendra, Kumar, Arun, Yadav, Pradeep, Kumar, Mandeep and Maurya, Brijesh Kumar (2022). Growth and Yield Response of different Indian Mustard [*Brassica juncea* (L.)] varieties to Irrigation Scheduling. *Biological Forum – An International Journal, 14*(3): 434-439.

Maurya, Shravan Kumar, Kalhapure, Aniket, Sah, Dinesh, Chaudhary, Manthan, Verma, Shikhar, Yadav, Rajat Kumar and Gupta, Devrani (2022). Effect of Irrigation Scheduling and Varieties on Yield, Yield Attribute and Profitability of Indian Mustard [*Brassica juncea* (L.)]. *International Journal of Plant & Soil Science, 34*(21): 379-386.

Pal, Sudhir, Kumar, Suresh, Gangwar, H. K., Singh, Ansul and Kumar, P. (2020). Effect of scheduling irrigation based on IW/CPE ratio on dry matter accumulation, yield attributes, yield and Economics of Wheat crop. *International Journal of Pharmacognosy and Phytochemistry, 9*(4): 1946-1949.

Pimpale, A. R., Rajankar, P. B., Wadatkar, S. B., Wanjari, S. S., and Ramteke, I. K. (2015). Estimation of water requirement of wheat using multispectral vegetation indices. *Journal of Agro-meteorology*, *17*(2): 208-212.

Rajanna, G. A., Dhindwal, A. S. and Sriharsha, V.P. (2016). Performance of clusterbean (*Cyamopsis tetragonoloba*) under variable irrigation schedules and crop-establishment techniques. *Indian Journal of Agronomy, 61*: 223-230.

Rajaram, S., Sayre, K. D., Diekmann, J., Gupta, R. and Erskine, W. (2007).Sustainability Considerations in Wheat Improvement and Production. *Journal of Crop Improvement, 19*: 1-2: 105-123.

Rana, K., Singh, J. P. and Parihar, M. (2019). Manifestation of improved cultivars, irrigation and sulphur in mustard growth, productivity, quality and profitability: A review. *Journal of Pharmacognosy and Phytochemistry, 8*(3): 2778-2782.

Rizk, A. H. and Sherif, M. M. (2014). Effect of Soil Moisture Depletion on the Yield of Wheat under Sprinkler Irrigation at Toshka Area, Egypt. *Middle East Journal of Agriculture Research, 3*(4): 981-987.

Singh, R.K., Kumar, H., and Singh, A.K. (2010). Brassica based intercroping systems- A review. *Agricultural Reviews*, *31*(4): 253-266.

Singh, S., Thenua, O. V. S. and Singh, V. (2018). Effects of phosphorus, sulphur and Irrigation on yield and NPS uptake of mustard + chickpea in intercropping system. *International Journal of Chemical Studies, 6*(4): 1341-1348.

Singh, Vikrant, Naresh, R. K., Kumar, Vineet, Chaudhary, Mayank, Mahajan, N. C., Sachan, D. K., Pandey, Akash, Yadav, Abhisekh and Jat, Lali (2018). Effect of Irrigation Schedules and Crop Establishment Methods on Physiological Processes, Light Interception, Water and Crop Productivity of Wheat under a Semiarid Agro-Ecosystem. *International Journal of Current Microbiology and Applied Sciences, 7*(12): 3427-3451.

Tripathi, S. C., Gill, S. C., and Meena, R. P. (2016). Intercropping of canola and mustard with wheat for higher profitability. *Journal of Wheat Research*, *8*(1): 30-33.

USDA. (2018). World Agricultural Production, United States Department of Agriculture Foreign Agricultural Service Circular Series WAP 3-18 March 2018.

USDA. (2020). World Agricultural Production, United States Department of Agriculture Foreign Agricultural Service Circular Series WAP 9-20 September 2020.

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.

How to cite this article: Jitendra Sisodiya, P.B. Sharma, Badal Verma, Muskan Porwal, Mahendra Anjna and Rahul Yadav (2022). Influence of Irrigation Scheduling on Productivity of Wheat + Mustard Intercropping System. *Biological Forum – An International Journal, 14*(4): 244-247.