RESEARCH ARTICLE

EFFECT OF IRRIGATION SCHEDULES AND BALANCED FERTILIZATION ON GROWTH AND PRODUCTIVITY OF TARAMIRA

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Abstract: A field experiment was conducted to study the impact of irrigation levels and balanced fertilization on growth parameters and yield of taramira [*Eruca sativa* (L.) Mill] during *rabi* season of 2017-18 at Agronomy Farm, S.K.N. College of Agriculture, Jobner. The experiment comprising three levels of irrigation (one irrigation at branching stage, two irrigation at branching and flowering and three irrigations at branching, flowering and pod formation stage) and five treatment comparisons for balanced fertilization (control, N_{30}, $N_{30} + P_{15}$, $N_{30} + P_{15} + K_{30}$ and $N_{30} + P_{15} + K_{30} + S_{40}$ kg/ha) there by making 15 treatment combinations was laid out in split plot design and replicated four times. Results showed that two irrigations the first at branching and the second at flowering stage significantly increased the growth characters *viz*., plant height at harvest (118.6 cm), dry matter accumulation at harvest (172.59 g/metre row length), chlorophyll content (0.991 mg/g), LAI (1.05), CGR during 60 DAS-at harvest (2.820 g/m/day), grain (1199 kg/ha), straw (3344 kg/ha) and biological (4543 kg/ha) yield of taramira. Although, three irrigations increased the yield over two irrigations but the increment was statistically not significant. Results further revealed that fertilization with nitrogen and phosphorous in taramira brought significant improvement in all the growth characters, grain (1153 kg/ha) straw (3095 kg/ha) and biological yields (4248 kg/ha) over control. Increase in growth parameters and yield owing to application of potassium as well as sulphur over N and P remained marginal.

Keywords: Growth, Fertilization, Flowering, Irrigation, Nitrogen, Taramira

INTRODUCTION

Taramira [*Eruca sativa* (L.) Mill] also known as "Rocket salad'' is a neglected crop of rapeseed and mustard group. It can be grown on a variety of soils on conserved moisture (Barani), as it is relatively a hardy plant. The oil of taramira is used mostly for non-edible purposes including industrial uses in the manufacturing of grease, soaps, plastics, lubricants, etc. Its cake is used as a nutritious feed for animals. Because of its efficient root system to extract moisture from deeper layers of soil, it is especially suitable for arid and semi-arid regions of Rajasthan. In Rajasthan, it covers about 763867 ha area with an annual production of 462938 MT with the productivity of 606 kg/ha (Anonymous, 2019).

It is generally cultivated on marginal and sub marginal lands of poor fertility without application of fertilizers which is one of the most important reasons of its poor productivity. The other important constraints of its low productivity are of water stress. The conserved soil moisture in such soils is not enough to replenish the water need and as such the crop suffers from water stress. Water resources have become scarce due to poor recharge of ground water, therefore, instead of intensive irrigation over a limited area, the right approach would be to serve maximum area with reduced number of irrigations to increase the overall production and water use efficiency which can be ensured by irrigating the crop at such phenological stages of growth which are very critical in their demand for water. The present study on irrigation aspect of taramira on loamy sand soils of semi arid region of the state aims to find out optimum number of irrigations with its right stage of application under limited irrigation water.

Balanced nutrient management is another basic requirement to realize potential yield. The soils of the region are not only deficient in nitrogen and phosphorus but also in sulphur. Farmers usually apply nitrogenous and phosphate fertilizers as recommended in the package of practices for the zone III-A but potash and sulphur fertilization is lacking in their fertilizer schedule. Nitrogen plays major role in early establishment of the leaf area and causes root development also, which enables more efficient utilization of available inputs. Phosphorus plays a significant role in the formation of energy rich phosphate bonds like ADP and ATP, nuclear protein and phospholipids. Likewise, potassium is involved in energy transfer, stomata movement, transformation of sugar and starch and nutrient movement in plants. It is well established that cruciferous group of oilseeds have relatively high sulphur acquiring capacity and requirement. Sulphur is essential for formation of S-containing amino acids vitamins (biotin and thiamine), co-enzyme-A, and metabolism of carbohydrates, protein and fats and glucosinolates, the SH-sulphydryl linkages provide the source of pungency in oils thus improves the quality of oilseeds. Keeping into cognizance the problems above addressed, present investigation was undertaken to analyze the response of taramira [*Eruca sativa* (L.) Mill] to irrigation levels and balanced fertilization.

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MATERIALS AND METHODS

An experiment was conducted during winter (*rabi*) season of 2017-18 at Agronomy Farm, S.K.N. College of of Agriculture, Jobner (26 05' North latitude, 75 28' East longitude and at an altitude of 427 metres above mean sea level) situated in agro-climatic zone III A (Semi-arid Eastern Plain Zone) in the state of Rajasthan. The soil was loamy sand, low in organic carbon (0.24%), low in available nitrogen (124.9 kg N/ha), medium in available phosphorus (16.21 kg P_2O_5/ha) and in available potassium (151.24 kg K_2O/ha). The experiment consisting of 15 treatments viz. three irrigation levels (one irrigation at branching stage, two irrigations at branching and flowering stages and three irrigations at branching, flowering and pod formation stages) as main plot treatments and five fertility levels (control, N_{30}, $N_{30} + P_{15}$, $N_{30} + P_{15} + K_{30}$ and $N_{30} + P_{15} + K_{30} + S_{40}$ kg/ha) as sub plot treatments was carried out in split plot design with four replications. Taramira variety RTM 1351 (Jobner Tara) was sown on the 6^{th} November, 2017 in the rows spaced at 30 cm apart with help of hand operated 'desi' plough with 'pora' attachment using a seed rate of 5 kg /ha. Calculated quantities of materials for supplying 30, 15, 30 and 40 kg/ha of N,P,K and S respectively through urea, DAP, MOP and gypsum were given at the time of sowing except urea which was top dressed at the time of first irrigation. One, two and three irrigations were applied at branching, branching and flowering and at branching, flowering and pod formation stage respectively. The crop was harvested on 7^{th} March, 2018, a net area of 3.0 m × 1.8 m was harvested separately from each plot to assess the biological, grain and straw yields from net plot area. At harvest, observations on plant height and branches/plant were taken from five random plants. In order to evaluate the effect of different treatments on growth necessary observations were recorded periodically

Total chlorophyll content of leaves at 45 DAS was determined using the method advocated by Arnon (1949) by taking 50 mg fresh leaf material.

Total chlorophyll (mg/g)

$$= \frac{A_{(652)} \times 29 \times \text{total volume (ml)}}{\alpha \times 1000 \times \text{weight of sample (g)}}$$

Where, α = is the path length = 1 cm

LAI was calculated by the following relationship (Watson, 1958).

$$\text{Leaf area index} = \frac{\text{leaf area (cm}^2)}{\text{Ground area (cm}^2)}$$

The CGR was calculated with following formula (Radford, 1967) from periodic dry matter recorded at different stages.

$$\text{CGR} = \frac{W_2 - W_1}{t_2 - t_1} \text{ (g / m}^2\text{ / day)}$$

Where,

W_1 = Total dry weight of plant at time t_1

W_2 = Total dry weight of plant at time t_2

t_1 = Time at first observation

t_2 = Time at second observation

The RGR of the crop was calculated by the following formula (Radford, 1967).

$$\text{RGR} = \frac{(\log_e W_2 - \log_e W_1)}{(t_2 - t_1)} \text{ (mg / g / day)}$$

Where,

W_1 and W_2 are total dry matter at time t_2 and t_1, respectively.

The analysis and interpretation of data were done using the Fischer's method of analysis of variance technique as described by Gomez and Gomez (1984). The levels of significance used in 'F' test were P = 0.05 and critical values were calculated wherever the 'F' test was found significant.

RESULTS AND DISCUSSION

Effect of Irrigation level on growth parameters

A critical examination of data (Table) revealed that the irrigation level had no significant effect on plant height and dry matter accumulation at 30 DAS. However, variation in plant height and dry matter accumulation due to irrigation levels was significant at 60 DAS and at harvest. Two irrigations at branching and flowering stages (I_2) recorded significantly higher plant height and dry matter accumulation over one irrigation at branching stage (I_1) at 60 DAS and at harvest. Two irrigation at branching and flowering stages was found at par with three irrigations at branching, flowering and pod formation stages in this regard. Three irrigations at branching, flowering and pod formation stages recorded significantly more number of branches (10.88) and leaf area index (1.09) in taramira indicating an increase of about 10.3 and 35.2 per cent and 9.4 and 13.5 per cent over two irrigation at branching and flowering and one irrigations at branching stages, respectively. Three irrigations at branching, flowering and pod formation stages recorded significantly highest chlorophyll content (0.999mg/g) in leaves. Data (table) further revealed that crop growth rate during 0-30 DAS did not differed significantly due to various levels of irrigation.

Application of two irrigations at branching and pod formation stages recorded significantly higher CGR over the previous level of irrigation during 30-60 DAS (1.464 g/m/day) and 60 DAS-harvest stage (2.820 g/m/day. However, it remained at par with three irrigations. Further, RGR increased with increased levels of irrigation but did not influenced significantly during 60 DAS- harvest. Increase in growth parameters might be attributed due to the fact that sufficient soil moisture was maintain by providing irrigation, had significant effect on the grain tissue area and higher photosynthetic assimilation, thus as a result plant growth improved with a higher accumulation of dry matter (Lal *et al.*, 2013). The results are also in conformity with those already reported by Yadav *et al.* (2010).

Effect of Irrigation level on Yield

It is clear from data (table) that grain yield of taramira was improved significantly with every increase in level of irrigation. The maximum grain yield (1287 kg/ha), straw yield (3395 kg/ha) and biological yields (4681 kg/ha) was recorded under three irrigation. It increased grain yield by the 439 kg/ha over one irrigation at branching. However, it was found at par with two irrigations at branching and flowering stages (I_2) which also recorded significantly higher grain, straw and biological yield over one irrigation.

The higher yield could be attributed to higher dry matter production and cumulative effect of yield attributes under existing climatic and soil conditions. Similar results were also obtained by Singh *et al.* (2011) for mustard crop. Panda *et al.* (2004) observed 62.9% and 41.7% increase in seed yield with irrigation at the flowering- and pod development stage over control in mustard.

Effect of balanced fertilizers on growth parameters

Data (table) revealed that balanced fertilization did not bring any significant influence on plant height at 30 DAS. Balanced fertilization involving nitrogen + phosphorus + potassium + sulphur (30+ 15 + 30 + 40 kg/ha) (N_4) significantly increased the plant height of taramira over control and N_1 (30 kg/ha) at 60 DAS upto harvest stages. But the same (N_4) was found at par with nitrogen + phosphorus (30 + 15 kg/ha) and nitrogen + phosphorus + potassium (30 + 15 + 30 kg/ha) with respect to plant height at 60 DAS and at harvest. The highest dry matter, branches /plant, leaf area index and chlorophyll content was recorded under (N_4) nitrogen+ phosphorus + potassium + sulphur (30 + 15 + 30 + 40 kg/ha). It increased the dry matter to the extent of 7.1 and 3.0 per cent at 60 DAS and 7.3 and 1.40 per cent at harvest stage in comparison to N_0 (control) and N_1 (nitrogen 30 kg/ha), respectively. N + P + K + S (30+15+30+40 kg/ha) (N_4) was found at par with N+ P (30+15 kg/ha) (N_2) and N + P + K (30+15+30 kg/ha) (N_3) with respect to dry matter at 60 DAS and at harvest. It increased the leaf area index by margin of 17 per cent as compared to N_0 (control). However, N_1, N_2 and N_3 were found at par with N 30 + P 15 + K 30 + S 40 kg/ha (N_4) with respect to leaf area index. It increased the chlorophyll content by margin of 7.07 per cent as compared to N_0 (control). A critical examination of data further showed that nitrogen 30 kg/ha + phosphorus 15 kg/ha+ potassium 30 kg/ha + sulphur 40 kg/ha (N_4) significantly increased the CGR during 30-60 days and 60 DAS-at harvest stages but did not differ significantly during 0-30 DAS stage. However, N_1, N_2, N_3 and N_4 was found at par with each other. Data further revealed that balanced fertilizers did not affect the RGR of taramira during all the growth stages.

The significant increase in above growth characters might be due to better nutritional environment in the root zone as well as in plant system under the influence of balanced fertilization. Thus increased uptake of nutrients in general and nitrogen in particular seems to have promoted vegetative growth in terms of plant height, dry matter/plant, probably by promoting greater meristamatic activity (cell division and enlargement) and as an integral constituent of chlorophyll by promoting greater photosynthetic activity. These results are in close conformity with those Singh *et al*. (2002), Verma *et al.* (2010), Kumar *et al.* (2016) and Dhruw *et al*. (2017).

Effect of balanced fertilizers on yield

Result further showed that application of balanced fertilization produced significantly higher grain yield of taramira than control (Table). The highest grain (1280 kg/ha), straw (3186kg/ha) and biological (4466 kg/ha) yield was obtained when N+P+K+S were applied @30+15+30+40 kg/ha (N_4) which registered a considerable increase of over, N_1, and control, respectively. However this treatment remained statistically at par with N_{30} + P_{15} + K_{30} (N_3) and N_{30} + P_{15} (N_2). The treatment N_2 remaining at par with N_3 significantly increased the grain, straw and biological yield by 37.75, 10.14 and 16.41 per cent respectively, over control.

The increasing levels of nutrient fertilization significantly improved yield attributes and yield. The improved overall growth due to nutrient application coupled possibly with increased net photosynthesis on one hand and greater mobilization of photosynthates towards reproductive structure on the other hand might have increased the yield attributes significantly. Significant increase in seed yield of taramira on account of nutrient fertilization thus seems to be cumulative effect of significant increase brought about dry matter production growth characters like plant height, number of branches per plant and yield attributes which eventually resulted in significant increase in seed yield/ha. Increase in seed yield with increasing levels of nutrient fertilization has also been reported by Singh *et al.* (2002), Kumar *et al.* (2016), Dhruw *et al.* (2017) and Kushwaha *et al.* (2017).

Table 1. Effect of irrigation levels and balanced fertilization on plant height (cm) and dry matter of taramira

Treatments	Plant height (cm)			Dry matter (g/metre)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Irrigation levels						
I_1-One irrigation at branching stage	70.6	93.2	105.2	43.05	81.14	160.12
I_2-Two irrigations at branching and flowering stages	73.5	103.7	118.6	44.08	87.99	172.59
I_3- Three irrigations at branching, flowering and pod formation stages	74.9	104.9	122.7	44.38	90.15	175.66
SEm±	1.6	2.2	2.7	0.94	1.72	3.11
CD (P = 0.05)	NS	7.8	9.2	NS	5.94	10.77
CV (%)	9.7	10.0	10.3	9.56	8.88	8.21
Balanced fertilization						
N_0-Control	70.4	88.0	102.0	42.78	82.54	160.82
N_1-Nitrogen	72.1	99.5	114.9	43.24	85.79	170.21
N_2-Nitrogen + Phosphorus	73.4	103.1	117.8	43.95	87.37	171.50
N_3-Nitrogen + Phosphorus + Potash	74.3	105.5	120.5	44.47	88.07	172.16
N_4-Nitrogen + Phosphorus +Potash + sulphur	74.8	106.8	122.2	44.75	88.36	172.59
SEm±	2.0	2.4	2.6	0.83	1.28	3.38
CD (P = 0.05)	NS	7.0	7.6	NS	3.67	9.70
CV (%)	9.6	8.4	7.9	6.53	5.12	6.92

Table 2. Effect of irrigation levels and balanced fertilization on number of branches/plant, chlorophyll content and leaf area index of taramira

Treatments	Number of branches/plant	Chlorophyll content (mg/g)	Leaf area index
Irrigation levels			
I_1-One irrigation at branching stage	8.05	0.908	0.96
I_2-Two irrigations at branching and flowering stages	9.86	0.991	1.05
I_3- Three irrigations at branching, flowering and pod formation stages	10.88	0.999	1.09
SEm±	0.24	0.021	0.02
CD (P = 0.05)	0.82	0.072	0.07
CV (%)	11.00	9.64	8.83
Balanced fertilization			
N_0-Control	7.86	0.905	0.93
N_1-Nitrogen	9.36	0.969	1.03
N_2-Nitrogen + Phosphorus	9.89	0.977	1.06
N_3-Nitrogen + Phosphorus + Potash	10.32	0.988	1.07
N_4-Nitrogen + Phosphorus +Potash + sulphur	10.56	0.992	1.09
SEm±	0.27	0.019	0.02
CD (P = 0.05)	0.77	0.054	0.07
CV (%)	9.73	6.72	8.14

Table 3. Effect of irrigation levels and balanced fertilization on CGR and RGR of taramira

Treatments	CGR (g/m/day)			RGR (mg/g/day)	
	0-30 DAS	30-60 DAS	60 DAS-At harvest	30-60 DAS	60 DAS-At harvest
Irrigation levels					
I_1-One irrigation at branching stage	1.435	1.270	2.633	21	23
I_2-Two irrigations at branching and flowering stages	1.469	1.464	2.820	23	22
I_3- Three irrigations at branching, flowering and pod formation stages	1.479	1.526	2.850	24	22

SEm±	0.032	0.020	0.056	1.05	1.11
CD (P = 0.05)	NS	0.070	0.148	2.85	NS
CV (%)	9.83	6.41	9.11	9.9	9.9
Balanced fertilization					
N_0-Control	1.426	1.325	2.609	22	22
N_1-Nitrogen	1.441	1.418	2.814	23	23
N_2-Nitrogen + Phosphorus	1.465	1.448	2.804	23	22
N_3-Nitrogen + Phosphorus + Potash	1.482	1.453	2.803	23	22
N_4-Nitrogen + Phosphorus +Potash + sulphur	1.492	1.454	2.808	23	22
SEm±	0.039	0.024	0.052	1.3	1.4
CD (P = 0.05)	NS	0.069	0.148	NS	NS
CV (%)	9.33	5.90	6.48	5.4	5.5

Table 4. Effect of irrigation levels and balanced fertilization on yield and harvest index of taramira

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)
Irrigation levels			
I_1-One irrigation at branching stage	848	2419	3267
I_2-Two irrigations at branching and flowering stages	1199	3344	4543
I_3- Three irrigations at branching, flowering and pod formation stages	1287	3395	4681
SEm±	26	68	90
CD (P = 0.05)	90	236	312
CV (%)	11	10	9
Balanced fertilization			
N_0-Control	837	2810	3647
N_1-Nitrogen	1066	3019	4084
N_2-Nitrogen + Phosphorus	1153	3095	4248
N_3-Nitrogen + Phosphorus + Potash	1221	3153	4374
N_4-Nitrogen + Phosphorus +Potash + sulphur	1280	3186	4466
SEm±	27	62	76
CD (P = 0.05)	78	179	218
CV (%)	8	7	6

CONCLUSION

Based on the results of one year experimentation, it may be concluded that two irrigations the first at branching and the second at flowering and application of nitrogen + phosphorus (N_{30} + P_{15}) were statistically superior treatments resulting into 1199 and 1153 kg/ha grain yield of taramira, respectively. Increase in yield due to application of potassium (30 kg/ha) as well as sulphur (40 kg/ha) over nitrogen and phosphorus was marginal.

REFERENCES

Anonymous (2017). Rajasthan Agricultural Statistics at a Glance 2016-17, Commissionerate of Agriculture, Rajasthan, pp. 92.

Arnon, D.I. (1949). Copper enzyme in isolated chloroplast polyphenol oxidase in *Beta vulgaris. Plant Physiology* 24 : 1-5.

Dhruw, S.S., Swaroop, N., Swamy, A. and Upadhayay, P. (2017). Effects of Different Levels of NPK and Sulphur on Growth and Yield Attributes of Mustard (*Brassica juncea L.*) Cv. Varuna. *International Journal of Current Microbiology and Applied Sciences,* 6(8): 1089-1098.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedure for Agricultural Research, A Wiley Inter-Science Publication, New York (USA), pp. 196-211.

Kumar, V., Nath, P., Kumar, R., Kumar, V., Verma, J.K. and Naresh, R.K. (2016). Interactive effect of sulphur and nitrogen on growth, yield and quality of Indian mustard (*Brassica juncea*). *International Journal of Science and Nature*. 7 (1): 57-61.

Kushwaha, C., Yadav, K.G., Yadav, K.K., Kumar, S. and Nishant (2017). Effect of nutrient management on yield and quality in Indian Mustard (*Brassica juncea* L.). *Journal of Plant Development Sciences* 9 (5) :501-504.

Lal, B., Hossain, M.S., Alam, M.B. and Ripon, M.A. (2013). Effect of irrigation and sowing method on yield and yield attributes of mustard. *Rajshahi University Journal of Life & Earth and Agricultural Sciences*. 41:65-70.

Panda, B.B., Shivay, Y.S. and Bandyopadhyay, S.K. (2004). Growth and development of Indian mustard (*B. juncea*) under different levels of irrigation and dates of sowing. *Indian Journal of Plant Physiology* **9**: 419-425.

Radford, P.J. (1967). Growth analysis formulae – their use and abuse. *Crop Science*. 7: 171-175.

Singh, F., Kumar, R., Kumar, P. and Pal, S. (2011). Effect of irrigation, fertility and topping on Indian mustard (*Brassica juncea*). *Progressive Agriculture*, **11** (2): 477-478.

Singh, S.K., Singh, Ghanshyam and Singh, G. (2002). Response of Indian mustard (*Brassica juncea*) varieties to nitrogen under varying sowing dates in eastern Uttar Pradesh. *Indian Journal of Agronomy*, 47:242-248.

Tandon, H.L.S. (1986). Sulphur research and agricultural production in India. Fertilizer Development and Consultation Organization, New Delhi.

Watson, D. J. (1958). The dependence of net assimilation rate on leaf area index. *Annals of Botany* 22 (1): 37-54.

Yadav, R.P., Tripathi, M.L. and Trivedi, S.K. (2010). Yield and quality of Indian mustard (*Brassica juncea*) as influenced by irrigation and nutrient levels. *Indian Journal of Agronomy* 55 (1): 56-59.

Verma, C.K., Bharti, S.S. and Yadav, R.B. (2010). Effect of fertilizer and moisture conservation practices on performance of mustard (*Brassica juncea* L.) under rainfed condition. *Journal of Plant Development Sciences* 2 (1 &2) : 5-8.