RESEARCH ARTICLE

EFFECT OF HYDROGEL AND FOLIAR SPRAY OF SALICYLIC ACID ON PRODUCTIVITY AND PROFITABILITY OF TARAMIRA

Priyanka Kumawat*, Manohar Ram, M.L. Jakhar, Varsha Kumari, D.K. Jajoria, B.R. Meena, S.S. Rajput and G.L. Kumawat

S.K.N. College of Agriculture, Sri Karan Narendra Agriculture University, Jobner, Rajasthan
Email: pkumawat.agro@gmail.com

Received-04.03.2021, Revised-13.03.2021, Accepted-28.03.2021

Abstract: A field experiment was conducted at Agronomy Farm, S.K.N. College of Agriculture, Jobner during *rabi* season of 2019-20 to evaluate the effect of hydrogel and salicylic acid on productivity and profitability of taramira under semi-arid conditions of Rajasthan. The experiment consisting of 9 treatment combinations,*viz.*T_1:control, T_2:hydrogel 2.5 kg/ha, T_3: hydrogel 5.0 kg/ha, T_4: salicylic acid (SA) 75 ppm at flowering (fl.) and siliqua formation (sf.),T_5:SA 100 ppm at fl and sf, T_6:hydrogel 2.5 kg/ha + SA 75 ppm at fl. and sf., T_7:hydrogel 2.5 kg/ha + SA 100 ppm at fl. and sf., T_8:hydrogel 5.0 kg/ha + SA 75 ppm at fl. and sf., T_9: hydrogel 5.0 kg/ha + SA 100 ppm at fl. and sf. were laid out in randomized block design with three replications. Results revealed that application of hydrogel 5.0 kg/ha with two spray of salicylic acid 100 ppm at flowering and siliqua formation stages recorded maximum plant height (113.10 cm), primary (7.63) and secondary (12.80) branches, siliqua/plant (133.20), seeds/siliqua (19.47), test weight (3.97g), seed yield (12.39 q/ha), gross return (₹ 47082/ha) and net return (₹29202 /ha) among all the treatments. However, this treatment was found statistically at par with hydrogel 5.0 kg/ha + salicylic acid 75 ppm at flowering & siliqua formation stages. Further, treatment T_2, T_3, T_4, T_5, T_6 and T_7 also recorded significantly higher growth and yield parameters over control. Thus, application of hydrogel 5.0 kg/ha with two spray of salicylic acid either 100 ppm or 75 ppm at flowering and siliqua formation stages was found beneficial for obtaining higher seed yield as well as net returns of taramira.

Keywords: Hydrogel, Productivity, Salicylic acid, Siliqua, Taramira

INTRODUCTION

Taramira (*Eruca sativa* Mill.) also known as "Rocket salad'' is a crop of rapeseed and mustard group, which has tremendous potential even under the situation of resource constraint. It is an introduced crop in India. It does not require much preparatory tillage due to efficient and fast penetrating root system permitting extrusion of soil water from deep soil layers. 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. In India, the chief taramira growing states are Rajasthan, Haryana, Punjab, Madhya Pradesh and Uttar Pradesh. 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. Rajasthan is the leading state in taramira, occupying more than 65 per cent area and contributes 60 per cent of the nation's production. In Rajasthan, it occupies about 763867 ha area with an annual production of 462938 MT with the productivity of 606 kg/ha (Anonymous, 2019).

The important constraints of low productivity of taramira are of water stress and other biotic and abiotic stresses. The conserved soil moisture in sandy soils of semi-arid regions of Rajasthan is not enough to replenish the water need and as such the crop suffers from water stress. Hence, intervention for adoption of improved scientific methods for improving the productivity by minimizing the impact of water stress during active growth period with the application of agro-chemicals will help to increase the productivity of the crop. Several technologies and agronomic practices have been developed and recommended for improving water productivity of crops. In this context 'Hydrogel', a novel semi-synthetic super absorbent polymer has shown potential to realize higher crop yield with limited water. A significant improvement in yield and water use efficiency in most of the test crops was reported by application of hydrogel (Anupama and Parmar, 2012). Hydrogel is an insoluble, cross-linked three-dimensional polymer which absorbs water more than 400 times of its weight and gradually releases it and also improves soil hydro-physical properties such as porosity, aggregate stability and hydraulic conductivity (Dabhi *et al*., 2013). Further study revealed that hydrogel not only reduces amount of irrigation water but also frequency of irrigation from 55 to 80% of total water requirements to the crop and, therefore, increases crop yield (El-Hady *et al.*, 2006).

Salicylic acid (SA) is a naturally occurring phenolic phytohormone acting as an important signaling molecule which adds to tolerance against abiotic stresses. It plays a vital role in plant growth, development, photosynthesis, transpiration, ion uptake and transport (Nasrin *et al*., 2014). It also plays a major role in osmotic adjustment and there by restricts to water loss from cell. Application of these

*Corresponding Author

chemicals together might provide a best management practice in order to improve the productivity of taramira under water scarce conditions. Keeping into cognizance the problems above addressed, this study was undertaken to evaluate effect of hydrogel and foliar spray of salicylic acid on growth and yield of taramira under rainfed condition of semi-arid eastern plain zone of Rajasthan.

MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) season of 2019-20 at Agronomy Farm, S.K.N. College 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 experimental field soil was loamy sand, low in organic carbon (0.24%), available N (132.8 kg/ha), available P (16.8 kg/ha) and medium in available K (148.6 kg/ha). The total of 9 treatment combinations, *viz.* T1: control, T2: hydrogel 2.5 kg/ha,T3: hydrogel 5.0 kg/ha,T4: salicylic acid (SA) 75 ppm at flowering and siliqua formation,T5: SA 100 ppm at flowering and siliqua formation,T6: Hydrogel 2.5 kg/ha + SA 75 ppm at flowering and siliqua formation,T7: Hydrogel 2.5 kg/ha + SA 100 ppm at flowering and siliqua formation, T8: Hydrogel 5.0 kg/ha + SA 75 ppm at flowering and siliqua formation, T9: Hydrogel 5.0 kg/ha + SA 100 ppm at flowering and siliqua formation were laid out in randomized block design with three replications.

Taramira variety RTM 1351 (Jobner Tara) was sown on 21st October, 2019 in the rows spaced at 30 cm apart using a seed rate of 5 kg /ha. A uniform basal dose of 30 kg N + 20 kg P_2O_5/ha through urea and DAP was drilled prior to sowing. Hydrogel, well mixed with sufficient quantity of soil was applied to allotted experimental plots in furrows just before the sowing of crops. Foliar pray of salicylic acid as per treatment were done at flowering and siliqua formation stage with the help of a knapsack sprayer. All the recommended agronomic practices were done throughout the crop season.

At harvest, five plants were selected from net plot and tagged for measurement of plant height, number of branches per plant, siliqua per plant and seeds per siliqua. At maturity, the net plots were harvested and sundried. The weight of the thoroughly sun dried harvested produce of each plot was recorded separately before threshing and expressed as biological yield in q/ha. After threshing, cleaning and drying, the seed yield was recorded. Economics of different treatments were worked out by taking into account the cost of inputs and income obtained from output based on the prevailing market price. 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

Growth and yield attributes

Results of the study (Table 1) indicated that application of hydrogel and salicylic acid and their combination had significant effect on growth and yield attributes of taramira over control. The application of hydrogel 5.0 kg/ha + salicylic acid 100 ppm at flowering & siliqua formation stages recorded significantly the highest plant height (113.10 cm), primary (7.63) and secondary (12.80) branches, siliqua/plant (133.20), seeds/siliqua (19.47) and test weight (3.97g) among all the treatments. However, it was found at par with hydrogel 5.0 kg/ha + salicylic acid 75 ppm at flowering & siliqua formation stages in this regard. The next best treatment in this order was hydrogel 2.5 kg/ha + salicylic acid 100 ppm at flowering & siliqua formation stage. Augmentation in crop growth parameters with the application of hydrogel might be due to its property of retaining and releasing water to maintain proper soil moisture for longer period in the rhizosphere. Adequate moisture content in soil facilitates better root growth, proper translocation and uptake of nutrients in the soil by the plants, which support better plant growth. Use of hydrogel made available soil moisture to optimum level during growth period, which helped in better leaf area expansion and photosynthesis, ultimately greater plant growth and development, reflected from higher values of yield attributes. Further, foliar spray of salicylic acid at flowering and siliqua formation stages created better nutritional environment in soil plant system resulted in minimized environmental stress i.e. temperature and drought stress which ultimately enhanced all the growth and yield attributes of crop. Similar results of higher growth and yield attributes with the application of hydrogel and salicylic acid were also reported by Meena *et al.* (2020) in mustard. Similar findings were also reported by Rehman *et al*. (2011) in rice, Das *et al.* (2013) in sorghum, Shatpathy *et al.* (2014) in rice and Dar and Hariram (2016) in wheat.

Yield and economics

Application of hydrogel 5.0 kg/ha + salicylic acid 100 ppm at flowering & siliqua formation stages recorded significantly the highest seed yield of taramira (12.39 q/ha) among all the treatments (Table 2). However, it was found at par with hydrogel 5.0 kg/ha + salicylic acid 75 ppm at flowering & siliqua formation stages (12.17 q/ha). Further, application of hydrogel 2.5 kg/ha + salicylic acid 100 ppm at flowering & siliqua formation stages (11.44 q/ha) also increased the yield over control and alone application of hydrogel and salicylic acid but remained statistically at par with hydrogel 2.5 kg/ha + salicylic acid 75 ppm at flowering & siliqua formation stages (11.13 q/ha). These four treatments

improved the seed yield to the extent of 37.36, 34.92, 26.82 and 23.39 per cent over control, respectively. This increment in crop yield with application of hydrogel might be a result of higher plant growth and yield attributes due to optimum availability of water compared to other treatments. The results of present investigation are in close agreement with the findings of Akhter *et al.* (2004) and Rehman *et al.* (2011) who stated that application of hydrogel resulted in higher crop productivity. Increase in seed yield with foliar spray of salicylic acid could be due to increase in physiological processes and efficient translocation of photosynthates towards reproductive organs which reflected in higher seed yield of taramira. Similar results were also obtained by Muhal *et al.* (2014) in *Brassica sp.* and Hassanein *et al.* (2012) in wheat. Further higher seed yield of taramira under combined application of hydrogel and salicylic acid in comparison to their alone application could be due to an additive effect on growing crop since hydrogel improve soil moisture level and salicylic acid minimizes environmental stress simultaneously. Similar results were also reported by Meena *et al.* (2020) in mustard. Further, the low yield of taramira in control treatment could be due to the fact that lack of moisture affected various physiological processes adversely which reflected in growth attributing characters and ultimately in the grain yield (Nirwal *et al*., 2013)

The higher gross and net returns of ₹47082 and 29202/ha was obtained with application of hydrogel 5.0 kg/ha + salicylic acid 100 ppm at flowering & siliqua formation stages followed by hydrogel 5.0 kg/ha + salicylic acid 75 ppm at flowering & siliqua formation stages (₹ 46246 and 28516/ha), hydrogel 2.5 kg/ha + salicylic acid 100 ppm at flowering & siliqua formation stages (₹43561 and 29321/ha) and hydrogel 2.5 kg/ha + salicylic acid 75 ppm at flowering & siliqua formation stages (₹42281 and 28191/ha). However, maximum B:C ratio (2.69) was recorded with foliar spray of salicylic acid 100 ppm at flowering & siliqua formation stages followed by salicylic acid 75 ppm (2.63). The higher crop productivity might be the principal reason for higher economic returns with application of hydrogel and salicylic acid as compared to control. Similar results of higher profitability were also reported by Rehman *et al.* (2011) and Meena *et al.* (2020).

Table 1. Effect of hydrogel and foliar spray of salicylic acid on growth and yield attributes of taramira

Treatments	**Plant height (cm)**	**Branches / plant**		**Siliquae/ plant**	**Seeds/ siliqua**	**Test weight (g)**
		Primary	**Secondary**			
$T_{1=}$Control	90.53	5.60	8.03	94.33	15.97	3.28
$T_{2=}$ Hydrogel 2.5 kg/ha	98.90	6.60	9.33	106.83	17.33	3.62
$T_{3=}$ Hydrogel 5.0 kg/ha	100.47	6.87	9.77	107.10	17.67	3.66
$T_{4=}$ Salicylic acid 75 ppm at flowering & Siliqua formation	96.70	6.53	9.17	103.13	17.30	3.61
$T_{5=}$ Salicylic acid 100 ppm at flowering & Siliqua formation	99.77	6.77	9.53	106.33	17.40	3.63
$T_{6=}$ Hydrogel 2.5 kg/ha + Salcylic acid 75 ppm at flowering & Siliqua formation	107.47	7.00	10.93	119.17	18.13	3.83
$T_{7=}$ Hydrogel 2.5 kg/ha + Salicylic acid 100 ppm at flowering & Siliqua formation	109.50	7.13	11.13	122.17	18.50	3.84
$T_{8=}$ Hydrogel 5.0 kg/ha + Salicylic acid 75 ppm at flowering & Siliqua formation	111.23	7.40	12.43	126.00	19.30	3.91
$T_{9=}$ Hydrogel 5.0 kg/ha + Salicylic acid 100 ppm at flowering & Siliqua formation	113.10	7.63	12.80	133.20	19.47	3.97
CD at 5%	7.48	0.62	1.12	11.68	1.27	0.22
CV (%)	7.26	9.07	10.85	10.33	7.10	6.02

Table 2. Effect of hydrogel and foliar spray of salicylic acid on yield and economics of taramira

Treatments	Seed yield (q/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
$T_{1=}$Control	9.02	34263	24263	2.43
$T_{2=}$ Hydrogel 2.5 kg/ha	10.10	38393	24753	1.81
$T_{3=}$ Hydrogel 5.0 kg/ha	10.75	40863	23583	1.36
$T_{4=}$ Salicylic acid 75 ppm at flowering & Siliqua formation	9.97	37886	27436	2.63
$T_{5=}$ Salicylic acid 100 ppm at flowering & Siliqua formation	10.30	39140.	28540	2.69
$T_{6=}$ Hydrogel 2.5 kg/ha + Salicylic acid 75 ppm at flowering & Siliqua formation	11.13	42281	28191	2.00
$T_{7=}$ Hydrogel 2.5 kg/ha + Salicylic acid 100 ppm at flowering & Siliqua formation	11.46	43561	29321	2.06
$T_{8=}$ Hydrogel 5.0 kg/ha + Salicylic acid 75 ppm at flowering & Siliqua formation	12.17	46246	28516	1.61
$T_{9=}$ Hydrogel 5.0 kg/ha + Salicylic acid 100 ppm at flowering & Siliqua formation	12.39	47082	29202	1.63
CD at 5%	0.90	3560	3560	0.27
CV (%)	8.59	8.68	13.14	13.35

CONCLUSION

Based on the results of one year experimentation, it may be concluded that application of hydrogel 5.0 kg/ha with two spray of salicylic acid either 100 ppm or 75 ppm at flowering and siliqua formation stages resulted in significant improvement in the growth, productivity and profitability of taramira. Thus, application of hydrogel and salicylic acid can be advocated as sustainable strategy for enhancing productivity and profitability of taramira under arid and semi-arid conditions.

ACKNOWLEDGEMENT

The authors are highly thankful to ICAR-DRMR, Sewar, Bharatpur (Raj.) for providing financial support and all necessary facilities to conduct the research work.

REFERENCES

Akhter, J.; Mahmood, K.; Malik, K.A.; Mardan, A; Ahmad, M. and Iqbal, M. M. (2004). Effects of hydrogel amendment on water storage of sandy loam and loam soils and seedling growth of barley, wheat and chickpea. *Plant Soil and Environment*, 50 (10): 463–9.

Anonymous (2019). Rajasthan Agricultural Statistics at a Glance 2019, Commissionerate of Agriculture, Rajasthan, pp.

Anupama and Parmar, B. S. (2012). Pusa hydrogel–An indigenous semi-synthetic super absorbent technology for conserving water and enhancing crop productivity. Success Story 14, IARI, New Delhi.

Dar, S. B. and Hariram (2016). Grain yield, nutrient uptake and water-use efficiency of wheat (*Triticum aestivum*) under different moisture regimes, nutrient and hydrogel levels. *Indian Journal of Agronomy* 61 (1):101-104.

EI-Hady, O. A.; Camilia, Y. and Dewiny, E. I. (2006). The conditioning effect of composts (natural) and acrylamide hydrogels (synthesized) on sandy calcareous soil. I. Growth response, nutrients uptake and water and fertilizer use efficiency by tomato plants. *Journal of Applied Science Research* 2 : 890-98.

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

Hassanein, R.A.; Abdelkader, A.F.; Ali,H.; Amin, A.A.E. and Rashad, E.M. (2012). Grain primary and foliar pretreatment enhanced stress defense in wheat (*Triticum aestivum* var. Gimaza) plants cultivated in drought land. *Australian Journal of Crop science*, 6: 121-129.

Hussein, M. M.; Rezk, A. I.; . El-Nasharty, A. B and Mehanna, H. M. (2015). Nutritional and growth response of Canola plants to salicylic acid under salt stress conditions. *International Journal of ChemTech Research,* 8: 574-581.

Ladha, J. K.; Singh, Y.; Erenstein, O. and Hardy, B. (2009). Integrated Crop and Resource Management in the Rice–Wheat Systems of South Asia. International Rice Research Institute, Los Banos, Philippines.

Meena, B. S.; Narolia,R. S.; Meena, L. K.; Meena, K. C. and Meena, S. N. (2020). Evaluation of Hydrogel and Salicylic Acid Application Effect on Yield, Quality, Economics and Water-Use Efficiency of Indian Mustard (*Brassica juncea*) in Restricted Irrigation Condition of S-E Rajasthan. *International Journal of Current Microbiology and Applied Sciences*, 9 (05): 3274-3283.

Muhal, S; Solanki, N.S.; Singh, P.; and Shukla, K.B. (2014). Effect of salicylic acid on productivity and nutrient uptake of *Brassica species* under different planting durations. *African Journal of Agricultural Research*, 9 (13):1101-1106.

Nasrin, M.; Nejad, F. M. and Zeinali, H. (2014). Effect of salicylic acid and salinity on some morphological characteristics of *Aloe vera*. *Ann.Bio. Sci*, 2: 68-71.

Nirwal, J.; Singh, S.P. and Panwar, J.D.S. (2013). Enhancement of growth parameters of chickpea genotypes through foliar application of urea under rainfed and irrigated conditions. *Journal of Plant Development Sciences*, 5 (2): 147-153.

Rehman, A.; Ahmad, R. And Safdar, M. (2011). Effect of hydrogel on the performance of aerobic rice sown under different techniques. *Plant, Soil and Environment*, 57:321-325.

Shatpathy, P.; Kar, M.; Singh, P.S. and Kumar, S. (2014). Physiological and biochemical manifestations of salicylic acid in rice under water stress condition. *Journal of Plant Development Sciences*, 6(4) : 563-568.