Environment and Ecology 38 (3A) : 493—497, July—September 2020
ISSN 0970-0420

Enhancing Productivity and Profitability of Indian Mustard by Hydrogel and Thiourea under Moisture Stress Condition

Abhinandan Singh, Amit Kumar Singh

Received 18 April 2020; Accepted 13 June 2020; Published on 2 July 2020

ABSTRACT

The field experiment was conducted during the *rabi* seasons of 2013-2014. The said experiment was laid out in Randomized Block Design consisted 13 treatments and 3 replications. The 100% recommended dose of NPK (60-40-30 kg/ha) was applied with hydrogel @ 2.5 kg/ha as basal followed by thiourea @ 0.05% as foliar spray at 50% flowering and 50% pod formation (as alone or in combination) to Indian mustard except control. However, Lucid improvement in growth parameters (plant height 125.72 cm, dry matter accumulation 17.26 g/plant and leaf area index 3.40, 5.38 at 45 and 75 DAS respectively). Phenological events (days to attain 50% flowering and 80% maturity) and productivity efficiency (45.5 kg/ha day) of mustard were recorded due to application of 2.5 kg/ha of hydrogel + 0.05% of thiourea at 50% flowering and 50% pod formation. However, the various treatments applied to mustard failed to influence the level of significance in terms of number of days taken to attain 50% flowering. The net return, economic efficiency and B : C ratio due to application of T_{12} and T_{13} though remained comparable but both were proved statistically more remunerative than rest of the treatments.

Keywords Moisture stress, Hydrogel, Thiourea, Productive efficiency, Economic efficiency.

Abhinandan Singh*
NRM, Center of Excellence in Dryland Agriculture Project, BUAT, Banda, UP 210001, India

Amit Kumar Singh
Department of Agronomy, BUAT, Banda, UP 210001, India
Email : agabhi92@gmail.com
*Corresponding author

INTRODUCTION

Indian mustard (*Brassica juncea*) belongs to the family Brassicaceae. It is one of the most important winter oilseed crops cultivated as rainfed under lowlands and foot hills of Manipur. During the year 2014-15 in India, the area of 67.5 Lakh hectare and production of 79.6 Lakh tone, with a productivity of 1088 kg/ha, respectively were recorded under rapeseed and mustard (APR, ICAR-DRMR, Bharatpur 2015). Since, last decade, the production and productivity of rapeseed and mustard had become constant and the same is not found sufficient to meet the countries as well as state's growing edible oil demands. Scarcity of water during the crop growth period has become the major challenges for marginal and small farmers for cultivation of mustard in the state and country as well. Irrigation water is becoming increasingly limited in India and hence it is important to improve the water use efficiency of plant. With improved water use efficiency (WUE), limited amount of available water can be used effectively. The presence of water in the soil is essential for vegetation which ensures the feeding of plants with nutritive elements and makes it possible for the plants to obtain a better growth rate. Hence, intervention for adoption of improved scientific methods for improving the productivity by decreasing the impact of water stress during active growth period with the application of chemicals and anti-transparent will help to increase the productivity of the crop. It seems to be interesting to exploit the existing water potential by use of soil conditioners like super absorbent polymer (hydrogel) may prove as a practically convenient and economically feasible option to achieve the goal of agricultural productivity under conditions of water scarcity. It can be easily applied directly in the soil at the time of sowing of field crops. Agricultural hydrogels are eco-friendly, because they are naturally degraded over a period of time, without leaving any toxic residue in the soil and crop products. Hence application of hydrogel will be a fruitful option for increasing agricultural production with sustainability in water-stressed environment. Thiourea, a sulfahydral compound, is known to improve the productivity of oilseeds and its role as a drought ameliorant is well established under the sub-tropical regions. The high Sulfur application is required in *Brassica* which usually higher than cereals and legumes for achieving higher yield productivity and better profitability. The foliar applications of thiourea at critical crop stages particularly flowering and pod filling stages, improved not only the photosynthetic efficiency, but also assimilated better partitioning and increased shoot dry matter (Jagetiya and Kaur 2006). Keeping these facts in view the present study was conducted to assess the effect of hydrogel and thiourea on growth, productivity and economic efficiency of Indian mustard under moisture stress condition.

MATERIALS AND METHODS

The field experiment was conducted during 2013-14 with view to judge the effect of hydrogel and thiourea on growth, productivity and economic efficiency of Indian mustard under moisture stress condition at Research Farm, Andro of Central Agricultural University Imphal in North-Eastern Hill Region of India (94˚0.0346″ E longitude, 24˚0.4589″ N latitude and an altitude of 875.0 meter above sea level) with Indian mustard variety NRCHB-101. In general, the experimental soil was clay loam with pH 5.6 and was highly fertile-being high in available organic carbon (0.93%) and medium in available nitrogen (292.18 kg/ha) as well as available potassium (304 kg/ha) and low in available phosphorus (18.0 kg/ha). The said experiment was subsequently laid out in Randomized Block Design involved 13 treatments and 3 replications. The 100% recommended dose of fertilizers i.e. 130 kg of Urea, 250 kg of SSP and 50 kg of MOP were applied. However, the crop was thickly sown at a row spacing of 30.0 cm and later on plant to plant distance was maintained at 10-12 cm by two thinning done at 25 and 35 DAS, respectively. Over and above, all the recommended agronomic practices were followed to mustard for harvesting good crop yield. Growth parameters viz. plant height, dry matter accumulation, LAI, No. of days taken to attain 50% flowering, 80% maturity and seed yield along with net return and profit/rupee invested were highly emphasized in this manuscript. However, all the data pertaining to the present investigation were subjected to statistical analysis by SAS version-9. Analysis of variance (ANOVA) for RBD was computed out to assess the response of treatment variables.

RESULTS AND DISCUSSION

Among the moisture stress management practices during field experimentation, the treatment T_{13} which received 2.5 kg/ha hydrogel as basal accompanied with foliar application of thiourea @ 0.05% twice at 50% flowering as well as 50% pod formation stage produced the taller plants, accumulated heavier dry matter, increased LAI and proved distinct superi-

Table 1. Effect of hydrogel and thiourea on growth of Indian mustard under moisture stress condition. T_1 : Control, T_2 : Water spray at 50% flowering, T_3 : Water spray at 50% pod formation, T_4 : Water spray at 50% flowering and 50% pod formation, T_5 : 2.5 kg hydrogel/ha with water spray at 50% flowering, T_6 : 2.5 kg hydrogel/ha with water spray at 50% pod formation, T_7 : 2.5 kg hydrogel/ha with water spray at 50% flowering and 50% pod formation, T_8 : 0.05% thiourea at 50% flowering, T_9: 0.05% thiourea at 50% pod formation , T_{10} : 0.05% thiourea at 50% flowering and 50% pod formation. T_{11} : 2.5 kg hydrogel/ha with 0.05% thiourea at 50% flowering, T_{12} : 2.5 kg hydrogel/ ha with 0.05% thiourea at 50% pod formation, T_{13} : 2.5 kg hydrogel/ha with 0.05% thiourea at 50% flowering and 50% pod formation.

Treat- ments	Plant height (cm)	Days to attain 50% flowering	Days to attain 80% crop maturity	Dry matter accumulation (g/plant)	Leaf area index 45 DAS	Leaf area index 75 DAS
T_1	83.96	63.33	112.33	11.43	2.75	4.47
T_2	100.52	62.67	114.67	12.84	2.92	4.81
T_3	103.23	63.00	114.67	13.15	2.93	4.78
T_4	112.19	62.67	115.33	14.92	3.02	4.93
T_5	106.29	60.33	115.33	14.52	2.93	4.88
T_6	115.08	60.00	116.00	14.73	2.92	4.93
T_7	120.81	60.00	116.00	16.16	3.22	5.12
T_8	98.67	62.00	115.00	13.90	2.96	4.80
T_9	98.99	62.33	114.33	14.19	2.94	4.80
T_{10}	107.58	62.00	114.33	16.20	3.04	5.00
T_{11}	112.39	60.67	116.67	16.45	3.11	5.06
T_{12}	115.76	60.67	117.33	16.58	3.15	5.06
T_{13}	125.72	60.00	117.67	17.26	3.40	5.38
SEm ±	3.44	1.20	0.79	0.69	0.10	0.14
CD (0.05)	10.04	3.51	2.31	2.01	0.28	0.42
CV (%)	5.53	3.38	1.19	8.08	5.51	5.02

ority over rest of the treatments (Tables 1 and 2). An increase in plant height might be attributed to water availability and indirectly nutrients provided by hydrogel, which have been reported to increase the activity of cell division, cell expansion and cell elongation, ultimately leading to an increased plant.

Table 2. Effect of hydrogel and thiourea on yield and economics of Indian mustard under moisture stress condition. T_1 : Control, T_2 : Water spray at 50% flowering, T_3 : Water spray at 50% pod formation, T_4 : Water spray at 50% flowering and 50% pod formation, T_5 : 2.5 kg hydrogel/ha with water spray at 50% flowering, T_6 : 2.5 kg hydrogel/ha with water spray at 50% pod formation, T_7 : 2.5 kg hydrogel/ha with water spray at 50% flowering and 50% pod formation, T_8 : 0.05% thiourea at 50% flowering, T_9 : 0.05% thiourea at 50% pod formation, T_{10} : 0.05% thiourea at 50% flowering and 50% pod formation, T_{11} : 2.5 kg hydrogel/ha with 0.05% thiourea at 50% flowering, T_{12} : 2.5 kg hydrogel/ha with 0.05% thiourea at 50% pod formation, T_{13} : 2.5 kg hydrogel/ha with 0.05% thiourea at 50% flowering and 50% pod formation.

Treat- ments	Seed yield (kg/ha)	% Increment/ decrement Control	% Increment/ decrement Water	Productivity efficiency (kg/ha/day)	Net return (Rs/ha)	Economic efficiency (Rs/ha/ day)	B : C ratio
T_1	541.1	0.00	-33.43	25.1	1860	16.1	0.10
T_2	688.3	21.39	-26.28	26.0	527	4.5	0.02
T_3	737.6	26.64	-17.83	28.1	2375	20.2	0.09
T_4	869.2	37.75	0.00	32.2	6716	56.8	0.26
T_5	920.2	41.20	5.55	32.7	5598	47.3	0.19
T_6	1000.6	45.92	13.13	35.2	8457	71.1	0.29
T_7	1170.3	53.76	25.73	39.8	13556	113.9	0.45
T_8	822.9	34.22	-5.66	30.8	5127	43.5	0.20
T_9	878.1	38.38	1.02	32.1	6993	59.6	0.27
T_{10}	1038.8	47.91	16.33	34.9	11955	101.9	0.45
T_{11}	1156.9	53.23	24.87	38.9	13608	113.7	0.47
T_{12}	1222.9	55.75	28.92	40.7	16008	133.0	0.55
T_{13}	1416.3	61.79	38.63	45.5	22288	184.7	0.75
SEm ±	53.9	–	–	1.6	3066	17.2	0.04
CD (0.05)	157.3	–	–	4.7	8950	51.7	0.13
CV (%)	9.7	–	–	8.2	67.6	8.6	24.2

Similar results have been reported by Sivalapan (2001) in soybean. Earlier workers found significant increase in number of green leaves and LAI of pearl millet at various growth stages by foliar application of thiourea. The total dry matter production is an indication of the overall utilization of resources and light interception. Similarly, a significant increase in total dry matter due to hydrogel polymer was reported by Volkamar and Chang (1995) in canola and Yazadani et al. (2007) in soybean.

During 2013-14 2.5 kg hydrogel/ha applied and subsequently 0.05% of thiourea sprayed at 50% flowering and 50% pod formation took more days to attain 80% of physiological maturity than the control (Table1). Similarly, result was found by Marschner (1986) to increased leaf chlorophyll contents of canola cultivars by sulfur application was due to its role in chlorophyll synthesis which might delayed the leafsenescence asobserved from delayed flowering and maturity. The higher availability of phosphorus to the crop might have stimulated early flowering, this could be ascribed to the greater supplies of hydrogel and thiourea in addition to recommended fertilize dose to the crop.

The highest seed yield (1416.3 kg/ha) and productivity efficiency (45.5 kg/ha/day) were observed in T_{13} (100% RFD, 2.5 kg/ha of hydrogel + 0.05% thiourea at 50% flowering and 50% siliqua formation) during the year of experimentation. However, control gave the minimum seed yield of 541.10 kg/ha. The percentage increase in seed yield of 61.79, 38.62 and 17.36 over control, two application of water only at 50% flowering and 50% siliquae formation and two application thiourea @ 0.05% at 50% flowering and 50% siliquae formation. An increase in growth and yield in the present investigation could be because of sufficient availability of water and indirectly nutrients supplied by the hydrogel to the plants under water stress condition, which in turn lead to better translocation of water, nutrients and photo assimilates and finally better plant development. Similar results of incorporating hydrogel into the soil on yield have been reported by Sendur Kumaran et al. (2001) in tomato and El -Hady and Wanas (2006), El-Hady et al. (2006) in cucumber under water stress condition. Apart from this, the sink strength is also an important determinant of sucrose translocation. The higher conversion rate of sucrose into either starch or oil increases the sink strength that supports the accumulation of more photo assimilates required for its growth. Thus, enhanced source and sink strength is a desirable trait that most of the agronomists wish to achieve so as to enhance plant's harvest index and crop yield (Foulkes et al. 2011, Aranjuelo et al. 2013).

The highest net return (Rs 22,288/ha), economic efficiency (184.7 Rs/ha/day) and remunerative B : C ratio (0.75) were recorded with application of 100% RFD + 2.5 kg hydrogel/ha followed by 0.05% thiourea at 50% flowering and 50% pod formation. This clearly indicates that foliar applied thiourea and incorporated hydrogel not only improved the growth and yield but also improved the benefit to cost ratio.

CONCLUSION

In view of the above, it may be concluded that to achieve higher yield and monetary advantage as well as efficient resource utilization, mustard be applied at 2.5 kg/ha of hydrogel as basal and 0.05% thiourea as foliar twice at 50% flowering and 50% pod formation accompanied with 100% recommended N-P_2O_5-K_2O (60-40-30 kg/ha) under moisture stress condition.

REFERENCES

Annual Progress Report (2015) Annual Progress Report of All India Coordinated Research Project on Rapeseed-Mustard Published by ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan.

Aranjuelo I, Sanz-Saez A, Jauregui I, Irigoyen JJ, Araus JL (2013) Harvest index, a parameter conditioning responsiveness of wheat plants to elevated CO_2. J Exp Bot 64 : 1879—1892.

El-Hady OA, Camilia Y, Dewiny EI (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. J Appl Sci Res 2 (11) : 890—898.

El-Hady OA, Wanas SA (2006) Water and fertilizer use efficiency by cucumber grow under stress on sandy soil treated with acryamide hydrogels. J Appl Sci Res 2 (12) : 1293—1297.

Foulkes MJ, Slafer GA, Davies WJ, Berry PM, Sylvester-Bradley R (2011) Raising yield potential of wheat. Optimizing partitioning to grain while maintaining lodging resistance. J Exp Bot 62 : 469—486.

Jagetiya BL, Kaur MJ (2006) Role of thiourea in improving

productivity of soybean. Int J Pl Sci 1 : 308—310.
Marschner H (1986) Mineral nutrition of higher plants. Academic Press Inc London, UK.
Sendur Kumaran S, Natrajan S, Muthvel I, Sathiayamurthy VA (2001) Efficiency of graded doses of polymers on processing quality of tomato cv CO_3. J Madras Agric 88 (4-6) : 298–299.
Sivalapan S (2001) Effect of polymer on growth and yield of soybean (*Glycine max* L.) grown in a coarse textured soil. In : Proc Irrigation, 2001 Regional Conf, Toowoomba, Queensland, Aust, pp 93—99.
Volkamar KM, Chang C (1995) Influence of hydrophilic gel polymers on water relations, growth & yield of barley and canola. Can J Pl Sci 75 : 605—611.
Yazadani F, Allahadadi I, Akbari GA (2007) Impact of super absorbent polymer on yield and growth analysis of soybean (*Glycine max* L.) under drought stress condition. Pak J Biol Sci 10 (23) : 4190—4196.