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KC Sahoo
Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology O.U.A.T., Keonjhar, Odisha, India

Srimanta Kumar Sahoo
Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology O.U.A.T., Keonjhar, Odisha, India

Sukumar Tudu
Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology O.U.A.T., Keonjhar, Odisha, India

Mokika Ray
Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology O.U.A.T., Keonjhar, Odisha, India

Prasanta Kumar Majhi
Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology O.U.A.T., Keonjhar, Odisha, India

Corresponding Author:
KC Sahoo
Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology O.U.A.T., Keonjhar, Odisha, India

Effect of Hydrogel on growth, yield and Profitability of Linseed (*Linum utitatissimum* L.) under Rainfed condition

KC Sahoo, Srimanta Kumar Sahoo, Sukumar Tudu, Mokika Ray and Prasanta Kumar Majhi

Abstract
A field experiment was conducted to evaluate the impact of hydrogel on productivity of linseed variety Kartika under rainfed conditions during Rabi 2016-17 under AICRP on Linseed, RRTTS, Keonjhar, Odisha. The experiment was laid out in Randomised Complete Block Design (RCBD) in factorial treatment design with three hydrogel treatments in the main plot *viz.* H_1-100% hydrogel (2.5 kgha^{-1}), H_2-75% hydrogel (1.88 kgha^{-1}), H_3-50% hydrogel (1.25 kgha^{-1}) and four carriers *viz.* Sand, FYM, Vermi-compost and Gypsum in the sub plot. Carriers were applied @ 25 kg/ ha. Results revealed that application of hydrogel (100%) @2.5 kg ha^{-1} with vermi-compost recorded the highest plant population (202 plants/m^2), higher plant height (59.4 cm) and average no of capsules per plant (24.4) over other treatments. The data reveals that the highest seed yield (989 kgha^{-1}) was found with application of hydrogel (100%) @2.5 kg/ha with FYM followed by 100% of hydrogel with vermi compost (909.7 kgha^{-1}) and 50% of hydrogel with FYM (878.0 kgha^{-1}). The highest B:C ratio 1.77 was recorded with hydrogel (100%) @2.5 kgha^{-1} with FYM. Therefore application of hydrogel (100%) @2.5 kgha^{-1} with FYM is recommended to linseed for higher productivity and profitability.

Keywords: Hydrogel, linseed, productivity, profitability, B:C ratio

Introduction
Linseed (*Linum usitatissimum* L.) is one of the most important industrial oilseed crops of India and stands next to rapeseed-mustard in *rabi* season. India is the second largest producer of linseed, next to Canada in the world with an area of 5.25 lakh ha, total production of 2.11 lakh tons per annum and productivity of 403 kgha^{-1} (Dujeshwer and Singh, 2018) [3]. In India Madhya Pradesh leads in productivity and acerage followed by Uttar Pradesh and Maharashtra. Linseed is generally grown under rainfed condition by utilising the residual moisture of previous crop, for which the crop often suffers from water stress conditions which results in drastic decrease in productivity of the crop. The impact of water scarcity on agriculture has become more prominent under the climate change scenario, since agriculture sector consumes maximum water. More than 60% of the net cultivated area is under dryland condition and more than 30% of the area faces the problem of inadequate rainfall. Use of chemicals like antitranspirants and hydrogel are some of the methods adopted to improve the water-use efficiency in agriculture systems. Hydrogel is a synthetic polymer used for soil amendment. Hydrogel is insoluble, hydrophilic in nature and can absorb large quantity of water (Schacht, 2004) [8]. 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 and in the growth medium for nursery plantation. The low application rate (2.5-5.0 kg/ha) of hydrogel is effective for almost all the crops in relation to soil type and climate of India. The improvement in growth and yield attributing characters and yield of different field, ornamental and vegetable crops has been reported with the application of hydrogel (Kalhapure *et al.*, 2016) [7]. Hydrogels have great potential in areas where opportunity for irrigation is limited and can increase the water availability during crop establishment. The capacity of the hydrogel to absorb and retain water is as much as 80–180 times its original volume (Bowman, 1991)[2] while on weight basis it can absorb as high as 400 times its original weight (Kalhapure *et al.*, 2016) [7]. The hydrogels can also modify various physical properties of soil like infiltration rates, density, soil structure and compaction, etc. (El-Hady and Abo-Sedera, 2006) [6].

Therefore, the present investigation was aimed on to analyse the effect of hydrogel on growth, yield and profitability of Linseed under rainfed situation.

Material and Method

A field experiment was conducted to evaluate the impact of hydrogel on productivity of Linseed (variety Kartika) under rainfed conditions during *Rabi* season of 2016-17 under AICRP on Linseed, RRTTS, Keonjhar, Odisha. The experiment was laid out in RCBD in factorial treatment design comprising three replications with three hydrogel treatments in the main plot *i.e*. H_1-100% hydrogel (2.5 kg/ha), H_2-75% hydrogel (1.88 kgha^{-1}), H_3-50% hydrogel (1.25 kgha^{-1}) and four carriers *viz*. Sand, FYM, Vermi-compost and Gypsum in the sub-plot. Carriers were applied at the rate of 25 kg ha^{-1}. Soaking with hydrogel was done by mixing of required hydrogel with same amount of water and seed for 12 hrs before sowing. Furrow application of hydrogel was done just before the sowing of seeds. Although, hydrogel is not soluble in water but it makes semi-translucent material with seed. A uniform dose of fertilizer @ 40 kg N ha^{-1}, 20 kg P_2O_5 ha^{-1} was applied to the experimental plots. The observations such as plant population (m^2), plant height (cm), number of branches per plant, number of capsules per plant and seed yield (kg/ha) were recorded from the randomly selected five tagged plants.

Result and Discussion

Hydrogels are cross-linked polymers with a hydrophilic group which have the capacity to absorb large quantities of water without dissolving in water. Water absorption capacity arises from the hydrophilic functional groups attached to the polymer backbone while their resistance to dissolution arises from cross-links between network chains (Schacht, 2004) [8]. Hydrogels increases the water absorption capacity of the soil. They are biodegradable, therefore to the environment. The results from the present investigation showed that, application of hydrogel (100%) @2.5 kgha^{-1} with Vermi-compost recorded the highest plant population (202 plants/m^2) followed by FYM (189 plants/m^2). Application of hydrogel (100%) @ 2.5 kgha^{-1} with FYM recorded higher plant height (59.4 cm) and average no of capsules per plant (24.4) over the other treatments. Hydrogel have been reported to increase the activity of cell division, cell expansion and cell elongation, ultimately leading to an increased plant height. Similar results have been reported by Al-Harbi *et al*. (1996) [1] in cucumber. The yield data reveals that application of hydrogel (100%) @2.5 kgha^{-1} with FYM (989 kgha^{-1}) recorded the highest seed yield followed by 100% of hydrogel wit*h vermi*-compost (909.7 kg ha^{-1}) and 50% of hydrogel with FYM (878.0 kgha^{-1}). The B:C ratio 1.77 was recorded from hydrogel (100%) @2.5 kgha^{-1} with FYM which was the higher than the rest of the treatments. Therefore, application of hydrogel (100%) @2.5 kg/ha with FYM is recommended for higher productivity and profitability in linseed grown under rainfed condition. Similar results were also reported by Dujeshwer and Singh (2017, 2018) [3, 4].

Hydrogel not only function to absorb the water but also releases the water gradually as per the requirement of the plant. This helps in improved germination, rate of seedling emergence and rapid growth of root (EI-Rehirn Abd *et al*., 2004) [5]. In the present study also similar result was found. The plant population was highest at 100% hydrogel (2.5kg/ha). Hydrogel application increases the productivity in almost all the test crops such as cereals, oilseeds, vegetable crops and floricultural crops. This increases the agricultural productivity in terms of plant biomass, fruit size and seed yield. The present findings were in accordance with the results of many other crops like pearl millet (Singh, 2012) [10] and lentil (Shankarappa *et al*., 2020) [9].

Table 1: Effect of Hydrogel on growth, yield and yield attributes of Linseed under rainfed condition

Sl. No.	Hydrogel	Carrier (25 kg/ha)	Final plant population (m^2)	Plant Height (cm)	Av. No. of Capsules/Plant	Yield of Linseed (kg/ha)	Total cost of cultivation /ha	B:C
1.	100% hydrogel (2.5 kg/ha)	Sand	177.3	53.4	17.9	810.7	22334	1.45
2.		FYM	189.0	59.4	24.4	989.0	22359	1.77
3.		Vermi-compost	202.0	57.2	17.7	909.7	22459	1.62
4.		Gypsum	159.3	55.2	19.3	812.3	22459	1.45
5.	75% hydrogel (1.88 kg/ha)	Sand	169.7	57.6	20.5	703.3	21404	1.31
6.		FYM	176.7	58.2	15.6	877.0	21429	1.64
7.		Vermi-compost	156.7	53.6	15.3	830.3	21529	1.54
8.		Gypsum	156.3	55.4	16.9	737.7	21529	1.37
9.	50% hydrogel (1.25 kg/ha)	Sand	173.0	52.6	14.5	763.7	20459	1.49
10.		FYM	170.0	54.4	17.0	878.0	20484	1.71
11.		Vermi-compost	175.3	56.2	17.3	794.3	20584	1.54
12.		Gypsum	159.3	53.4	18.0	696.3	20584	1.35
13.	Control			172.7	14.5		655.7	1.41
			Control vs Rest		Comparing within Hydrogel		Comparing within Carrier	
	S.Em(±)		36.1		24.5		28.3	
	$CD_{(0.05)}$		105.2		71.5		82.5	

Conclusion

The applications of agricultural hydrogels are not only used for water saving in irrigation, but they also have tremendous potential to improve the biological and physico-chemical properties of the soil. This improves the porosity, bulk density and water holding capacity of the soil. The application of hydrogel can be a potential alternative to improve photosynthetic efficiency, assimilate partitioning, and increase growth and yield of the crop. In the present investigation higher productivity was recorded with the hydrogel dose of (100%) @2.5 kgha^{-1} with Vermi-compost. Thus, the above dose can be recommended to the farmer to generate more profit from the linseed cultivation under rainfed situations. Agricultural hydrogels are eco-friendly as they are bio-degraded over a period of time, without having any residual activity on the soil, crop and on the end products.

Hence application of hydrogel is a sustainable way to increase the agricultural productivity and profitability under water-stressed environment.

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