Effect of hydrogel and inorganic manure on the growth and yield of lettuce (*Lactuca sativa* L) under citrus-based agroforestry system

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ABSTRACT

A field experiment was conducted during rabi 2019-2020 at forest nursery of College of Forestry SHUATS, Prayagraj, Uttar Pradesh to find out the effects of hydrogel and inorganic manure on growth and yield of lettuce (*Lactuca sativa* L) under citrus-based agroforestry system. The experiment was laid out in RBD with hydrogel and inorganic manure constituting 13 treatments combinations. The investigations revealed that the treatment comprising hydrogel 2.5 kg + N 90 kg + P 75 kg + K 75 kg/ha recorded significantly higher values for survival percentage (87.80%), dry weight/plant (20.80 g), fresh weight/plant (144.90 g), leaf weight/plot (498.10 g) and B-C ratio (1:1.87). In case of other plant parameters it was also superior to others thoug at par with some of the treatments. Hence reatment comprising hydrogel 2.5 kg + N 90 kg + P 75 kg + K 75 kg/ha was best for higher growth rate of lettuce.

Keywords: Hydrogel; inorganic manure; lettuce; growth; yield

INTRODUCTION

Agroforestry systems make maximum use of the land. Every part of the land is considered suitable for useful plants. Emphasis is placed on perennial, multiple purpose crops that are planted once and yield benefits over a long period of time. Such benefits include construction materials, food for humans and animals, fuels, fibers and shade. Trees in agroforestry systems also have important uses such as holding the soil against erosion and improving soil fertility (Martin and Sherman 1992) (by fixing nitrogen or bringing minerals from deep in the soil and depositing them by leaf-fall). Citrus plants are shrubs to medium size trees up to about 6 m (20 ft) in height, although some species can reach 15 m (50 ft). Rootstocks can greatly affect the height of grafted trees. Trees have thin, smooth and gray-brown to greenish bark. Most species are single-trunked with very hard wood. Canopy widths range from slender to broad depending on species. Many cultivated species are pruned so that the canopy is as wide as the tree is tall. The roots, flowers, fruits and leaves of citrus are used in the form of juice and decoction to treat tastelessness due to fever, intrinsic hemorrhage, anemia, jaundice, hiccough, asthma, vomiting, pain in cardiac region, gulma, colic, pox, gravels, caries, for easy delivery, foul smell in flatus, erysipelas, head disease, anorexia during pregnancy and earache. It is an annual plant native to the Mediterranean area. Cultivation may have started as early as 4500 BC, perhaps initially for the edible oil extracted from its seeds. Salad lettuce was popular with the ancient Greeks and Romans. The primitive forms of lettuce were loose and leafy. Firm heading forms became well developed in Europe by the 16th century. Oak-leaved and curled-leaf types of various colours were described in the 16th and 17th centuries in Europe. Lettuce colour for commercial cultivars varies from a yellow-green to dark red and all colours in between. One of the most important limiting factors for plant growth and productivity is water. The problem of water scarcity is expected to rise in future because of three major reasons namely change in climatic condition, increase in population and the economic

activities of the developing countries. In order to overcome this crucial condition there is a need of conservation of moisture and continuous supply of water. This is possible with the use of super absorbent polymers (hydrogel). Hydrogel is basically a water absorbing polymer which is classified as cross-linked and absorbs aqueous solutions through hydrogen bonding with water molecules (Rehman et al 2011).

MATERIAL and METHODS

The present investigations were carried out in the forest nursery of College of Forestry SHUATS, Prayagraj, Uttar Pradesh. Thirteen treatments were given viz T_0 (Control: RDF= NPK 50:30:30 kg/ha), T_1 (Hydrogel 0.0 kg + N 90 kg + P 75 kg + K 75 kg/ha), T_2 (Hydrogel 0.0 kg + N 110 kg + P 80 kg + K 80 kg/ ha), T_3 (Hydrogel 0.0 kg + N 120 kg + P 85 kg + K 85 kg/ha), T_4 (Hydrogel 2.5 kg + N 90 kg + P 75 kg + K 75 kg/ha), T_5 (Hydrogel 2.5 kg + N 110 kg + P 80 kg + K 80 kg/ha), T_6 (Hydrogel 2.5 kg + N 120 kg + P 85 kg + K 85 kg/ha), T_7 (Hydrogel 5.0 kg + N 90 kg + P 75 kg + K 75 kg/ha), T_8 (Hydrogel 5.0 kg + N 110 kg + P 80 kg + K 80 kg/ha), T_9 (Hydrogel 5.0 kg + N 120 kg + P 85 kg + K 85 kg/ha), T_{10} (Hydrogel 7.5 kg + N 90 kg + P 75 kg + K 75 kg/ha), T_{11} (Hydrogel 7.5 kg + N 110 kg + P 80 kg + K 80 kg/ha), T_{12} (Hydrogel 7.5 kg + N 120 kg + P 85 kg + K 85 kg/ha). The research site was situated at an elevation of 98 m amsl at 25° 27' North latitude and 81° 51' E longitude. The soil of the experimental field was sandy loam in texture, medium in available phosphorus and comparatively medium in nitrogen and potash with normal pH 7. The experiment was arranged in randomized block design with three replications. Each replicated field was divided into nine treatments with each plot size of 4 m^2. Pre-sowing soil samples up to 30 cm depth were collected and analyzed for their physico-chemical properties such as organic carbon (Walkley 1947), total nitrogen by alkaline permanganate method (Subbiah and Asija 1956), phosphorus by Olsen's calorimetric method (Olsen et al 1954) and potassium by flame photometric method (Toth and Prince 1949). Soil pH and EC were measured by digital pH meter and conductivity meter respectively. The requisite agronomic and plant protection measures were adopted uniformly for all the treatments during the entire growing period. At maturity, data on plant characters and yield components were recorded from five randomly selected plants in each plot. The growth and yield characters were recorded such as plant height at harvest, number of leaves per plant, plant spread, survival percentage, average leaf area, average leaf weight, leaf weight per plant, dry weight per plant, fresh weight per plant, leaf weight per plot and leaf yield per hectare.

RESULTS and DISCUSSION

The data on the effect of hydrogel and inorganic manure on lettuce *(Lactuca sativa* L) are presented in Tables 1 and 2. The maximum plant height (33.20 cm) was observed in T_4 (2.5 kg/h hydrogel + 90 kg/h N + 75 kg/h P + 75 kg/h K) and T_{12} (Hydrogel 7.5 kg + N 120 kg + P 85 kg + K 85 kg/ha) (31.71 cm). T_4 was at par with T_5 (Hydrogel 2.5 kg + N 110 kg + P 80 kg + K 80 kg/ha) and T_8 (Hydrogel 5.0 kg + N 110 kg + P 80 kg + K 80 kg/ha) for the parameter number of leaves per plant having 34.26, 34.06 and 33.64 leaves respectively. T_4 (31.20 cm) was at par with T_2 (Hydrogel 0.0 kg + N 110 kg + P 80 kg + K 80 kg/ha) (28.13 cm), T_5 (29.17 cm), T_6 (29.09 cm), T_8 (31.06 cm) and T_{12} T_8 (30.71 cm) for the parameter plant spread. The treatments T_4 to T_{12} were at par for the parameter average leaf area and also average leaf weight per plant except T_6. T_4, T_8 and T_{12} were on far for the trait leaf weight per plant. In case of leaf yield per ha, T_4, T_5, T_8, T_9 and T_{12} all resulted in maximum yield. Treatment comprising hydrogel 2.5 kg + N 90 kg + P 75 kg + K 75 kg/ha recorded significantly higher values for survival percentage (87.80%), dry weight/ plant (20.80 g), fresh weight/plant (144.90 g), leaf weight/plot (498.10 g) and B-C ratio (1:1.87) than all other treatments.

Awaad et al (2016) reported that application of different sources of N alone or combined with potassium sulphate gave the highest fresh dry weight per plant and total lettuce yield per hectare compared with the control. Kumaran (2016) reported that the application of polymer TerraCottem 4.5 g/plant with recommended dose of manures and fertilizers (FYM 25 tonees + NPK 150:100:50 kg + *Azospirillium* 2 kg + phosphobacteria 2 kg/ha) followed by polyvinyl alcohol 15.0 g/plant with recommended dose of manures and fertilizers improved the growth, yield and quality of rainfed tomato. Singh (2012) revealed that effective tillers/plant, ear length, grain weight/earhead and test weight of pearlmillet were significantly influenced by seed treatment with hydrogel. The grain yield, stover yield and water use efficiency were also significantly influenced by the hydrogel application. Pazderu and Koudela (2013) reported that the hydrogel application influenced germination of lettuce and onion

Table 1. Effect of hydrogel and inorganic manure on growth parameters of lettuce under citrus-based agroforestry system

Treatment	Plant height (cm)	Number of leaves/plant	Plant spread (cm)	Survival percentage	Average leaf area (cm^2)
T_0	26.71	15.48	25.71	60.80	206.88
T_1	28.16	19.82	27.16	63.80	217.40
T_2	29.13	18.99	28.13	62.80	220.99
T_3	27.37	15.48	26.37	61.79	217.37
T_4	33.20	34.26	31.20	87.80	260.78
T_5	30.17	34.06	29.17	67.80	241.78
T_6	29.09	29.72	29.09	68.80	241.00
T_7	29.49	19.82	27.49	78.02	240.37
T_8	32.06	33.64	31.06	85.80	252.78
T_9	29.57	21.88	26.57	76.80	251.41
T_{10}	28.60	18.58	24.60	71.80	240.51
T_{11}	28.17	17.75	26.17	82.80	232.04
T_{12}	31.71	20.43	30.71	82.80	252.00
$CD_{0.05}$	3.552	0.745	3.552	1.984	30.784

T_0: Control: RDF= NPK 50:30:30 kg/ha, T_1: Hydrogel 0.0 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_2: Hydrogel 0.0 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_3: Hydrogel 0.0 kg + N 120 kg + P 85 kg + K 85 kg/ha, T_4: Hydrogel 2.5 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_5: Hydrogel 2.5 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_6: Hydrogel 2.5 kg + N 120 kg + P 85 kg + K 85 kg/ha, T_7: Hydrogel 5.0 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_8: Hydrogel 5.0 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_9: Hydrogel 5.0 kg + N 120 kg + P 85 kg + K 85 kg/ha, T_{10}: Hydrogel 7.5 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_{11}: Hydrogel 7.5 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_{12}: Hydrogel 7.5 kg + N 120 kg + P 85 kg + K 85 kg/ha

Table 2. Effect of hydrogel and inorganic manure on yield parameters of lettuce under citrus-based agroforestry system

Treatment	Average leaf weight/plant (g)	Leaf weight/plant (g)	Dry weight/plant (g)	Fresh weight/plant (g)	Leaf weight/plot (g)	Leaf yield/ha (tonnes)	B-C ratio
T_0	9.86	165.67	8.99	62.59	210.01	10.50	1:1.12
T_1	10.24	199.67	11.65	80.11	356.54	17.35	1:1.40
T_2	10.73	200.67	12.29	85.29	363.04	17.48	1:1.40
T_3	10.04	182.33	11.39	79.49	313.04	17.32	1:1.38
T_4	13.07	301.33	20.80	144.90	498.10	23.91	1:1.87
T_5	11.89	248.33	17.23	125.43	450.79	22.89	1:1.78
T_6	11.30	234.00	16.31	114.50	435.72	20.49	1:1.58
T_7	11.51	214.33	12.46	101.20	374.21	18.58	1:1.42
T_8	12.68	274.33	18.90	132.00	485.14	23.08	1:1.75
T_9	12.65	238.33	15.94	112.20	441.08	21.91	1:1.65
T_{10}	12.17	232.33	14.88	103.50	443.50	20.59	1:1.53
T_{11}	11.53	215.33	14.45	88.11	395.89	19.31	1:1.43
T_{12}	12.50	271.33	18.20	126.40	481.08	23.08	1:1.70
$CD_{0.05}$	1.557	42.163	1.256	2.444	6.605	3.018	

T_0: Control: RDF= NPK 50:30:30 kg/ha, T_1: Hydrogel 0.0 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_2: Hydrogel 0.0 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_3: Hydrogel 0.0 kg + N 120 kg + P 85 kg + K 85 kg/ha, T_4: Hydrogel 2.5 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_5: Hydrogel 2.5 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_6: Hydrogel 2.5 kg + N 120 kg + P 85 kg + K 85 kg/ha, T_7: Hydrogel 5.0 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_8: Hydrogel 5.0 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_9: Hydrogel 5.0 kg + N 120 kg + P 85 kg + K 85 kg/ha, T_{10}: Hydrogel 7.5 kg + N 90 kg + P 75 kg + K 75 kg/ha, T_{11}: Hydrogel 7.5 kg + N 110 kg + P 80 kg + K 80 kg/ha, T_{12}: Hydrogel 7.5 kg + N 120 kg + P 85 kg + K 85 kg/ha

seeds. Treated lettuce seeds germinated faster than non-treated control in the beginning of germination process. Although influence of Agrisorb was positive in the beginning, higher doses of hydrogel reduced germination energy of treated seed lots of both crops in comparison with non-treated control. Kumar et al (2018) showed that hydrogel, irrigation levels and their interactions had a significant effect on growth, fresh yield and essential oil content of ginger. Islam et al (2012) found that average maximum number of leaves, root length and yield per plot were observed by using cow dung 35 tonnes/ha while the lowest in control. The chicken litter fertilized plants had relatively higher average leaves length, leaves breadth and base diameter while the maximum dry matter content and yield per hectare were found by applying cow dung 25 tonnes/ha. The highest gross benefit-cost ratio of 1.40 was obtained from cow dung 25 tonnes/ha treatment.

CONCLUSION

On the basis of study it may be concluded that treatment of 2.5 kg/h hydrogel + 90 kg/h N + 75 kg/h P + 75 kg/h K was found to be the best for obtaining higher growth parameters in lettuce. While studying the effect of the same treatment on economics it was found to be the best for obtaining better benefit-cost ratio (1:1.87).

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