Study/Effect of total chlorophyll content and relative water content % of mini tuber potato under aeroponic condition in Jammu region

ABSTRACT

The present study, "Effect of total chlorophyll content and relative water content % of mini tuber potato under aeroponic condition in Jammu region" was conducted in the Division of Plant Physiology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The experiment was conducted during winter and spring seasons in 2022-23. Two varieties Kufri Badshah and Kufri Jyoti were taken as experimental material. Potato tubers were sown in net pots containing growing media and seedlings were transplanted at five leaves stage in the aeroponics system. The experiment was laid out in Completely Randomized Design with two treatments viz, T_1 (cocopeat 100%) and T_2 (cocopeat +vermiculite+ perlite+ vermicompost) in ratio (2:1:1:2%) and after two weeks of transplanting data was recorded at three different stages of crop growth (20 DAT, 45 DAT and 80 DAT). The results clearly indicated that treatment T2 coco peat + perlite + vermiculite + vermicompost in the ratio of 2:1:1:2 was the most promising treatment for improving the, biochemical parameters, physical parameters and quality of both potato varieties when compared to other treatments.

Keywords: *Solanum tuberosum L., soilless culture, Aeroponics, Mini tuber*

INTRODUCTION

Potato (*Solanum tubesosum* L.) belongs to the family Solanaceae and originated in high mountain areas of the Andes in South America. It is one of the most important staple food crop with high production per unit area with a short growing season, and consistent demand throughout the year, allowing for ongoing area expansion [1]. Although potatoes have gained popularity as a source of complex carbs and vitamins, with the added benefit of having a low-fat content, they are being explored as a solution to fulfil the world's increasing food needs [2]. Potato is also known as 'Poor man's food' because it provides the most energy at the lowest cost to the human diet [3]. The adoption of new production technologies, usage of better varieties, quality seed material, good storage facilities, and transportation in recent years have helped to expand area, production, and productivity in India. Potato is a vegetatively propagated crop; hence disease-free seed tubers are essential for commercial production. In most regions, including India, they are grown through vegetative propagules, with seed tubers being the largest input expense. Producing seed tubers in India's hills and subtropical plains during low aphid population periods and transporting them throughout the country for commercial fresh tuber production of potato cultivars, which blossom in long days, and tuberose in short days with cooler temperatures. The availability of virus-free planting material is a major barrier to potato growth in traditional field farming. Potato plants develop subterranean stems known as solons, which expand to form tubers under favourable environmental conditions [4]. It is an important crop in the region, contributing nearly 10% of the country's total potato area. Potato is a temperate-season crop that is planted in the winter and harvested in the early spring. It is known as the “king of vegetables". It is the most economical food and is considered a friend of poor men. Potato farming has been done in the United States for more than 300 years. Solanaceae is considered the world's most significant food crop. Potato plants tolerate acidic environments well, with optimal growth occurring between pH 5 and 6. The total area under potato cultivation in India is 2,208,000 hectares with a production and productivity of about 53603 MT [5]. In Jammu & Kashmir (UT), the total area under Potato cultivation is 8030 ha with an annual production of 197.87 Metric tons. Developing countries have been increasing potato production annually due to its nutritional relevance and the possibility of obtaining high yields per unit area. In a short growing cycle [6]. The sustainability of potato crop, however, depends partly on the use and availability of high-quality seeds (disease free), which are not always available to producers in underdeveloped countries [7]. Growing potatoes under high temperatures with low light quality and quantity, on the other hand, is challenging since both of these factors inhibit tuberization. Low ambient pH, on the other hand, has been shown to dramatically inhibit nutrient uptake, particularly in solution culture, and can significantly reduce plant growth and photosynthesis [8]. Field farming faces uncertainties and dangers due to high winds, floods, droughts, and pest attacks. Factors contributing to low yield include the non-availability of quality seeds, high costs, and biotic and abiotic stresses. One possible solution to this problem is to adopt a soil-less seed production system. Soilless farming systems offer numerous advantages, including the ability to solve many difficulties associated with land farming and achieve a high yield in terms of quantity and hygienic quality [9]. The absence of soil in these culture systems reduces the damage caused by pathogenic microorganisms [10]. In the Jammu region, growing mini tuber potatoes is facing challenges due to nematode attacks. So here, the alternative is aeroponic farming to achieve the best quality virus-free seed with the aeroponics technology for growing potatoes, they have a fast multiplicative rate. soil. Hydroponics is used worldwide by farmers and growers [11]. Aeroponics, a type a hydroponic that is gaining popularity for potato mini-tuber production, offering higher rates of multiplication, better health standards, and size regulation through sequential harvesting [12]. This system helps to face the challenges of climate change and also help in production system management for efficient utilization of natural resources. The space required for this system is limited thus it can fit into urban gardening, terrace gardening etc. Thus, by adopting them fresh crops and be grown throughout the year. Since they don't need fertile soil, the set-up can be incorporated in barren lands which is not fertile enough for agriculture thus the unutilized land can be made utilized. This could be one of the best ways to address the nutrition security for growing population. The emerging technologies like aeroponics creates possibilities to cultivate plants without soil where isolation distance is not required, system is free from soil/air borne pest, diseases and weeds, with minimal water (70-90 % less), nutrient (60-75 %) use and zero herbicides.

MATERIALS AND METHODS:

This study was carried out in the Department of Plant Physiology, Faculty of Basic Sciences, Sher-e-Kashmir University of Agricultural Science & Technology of Jammu, Main Campus Chatha, during 2022-23 from October 2022 to May 2023.Two varieties of Potato Kufri Badshah, and Kufri Jyoti were raised Kufri Badshah were raised in winter season and Kufri Jyoti in spring season

SUBSTRATES WAS USED IN THE EXPERIMENT:

Different substrates were used in research work are shown in Plate 1.

1) Coco peat
2) Perlite
3) Vermiculite
4) Vermicompost

NUTRIENTS SUPPLEMENT

The Green Loop Leafy-200 hydroponic nutrient was chosen for the experiment due to its adaptability and primary composition of both macro and micronutrients. It was often served with herbs, salad, and a variety of green vegetables. The nutrition consisted of two firmly sealed bottles, A and B, each containing a distinct sort of solid nutrient.

NUTRIENT COMPOSITION

Macronutrients

Calcium 23 per cent

Nitrogen 23 per cent

Phosphorous 7 per cent

Potassium 32 per cent

Magnesium 5.3 per cent

Sulphur 9 per ce

Micronutrients

(Boron, Chlorine, Manganese, Zinc, Copper, Sodium, Molybdenum, Iron, Chlorine) 0.7 per cent

LAY OUT OF EXPERIMENT

The experiment was laid out using Complete Randomized Design (CRD).

Treatments: Different growing media were used in different concentration

Treatment	**media / Substrates**	**Ratio**
T_1	coco peat	(100%)
T_2	coco peat + Perlite + Vermiculite + Vermicompost	(2:1:1:2)

Seeds of both varieties, Kufri Badshah and Kufri Jyoti, were planted in an aeroponics net pot inside the Plant Physiology laboratory. Kufri Badshah was planted in an aeroponics net pot on October 3, 2022, as shown in Plate (1), and Kufri Jyoti was planted in an aeroponics net pot on February 20, 2023, with media in different treatment as already given in the table i.e. $T_1$and T_2 Seedlings of both varieties emerged after one week .and after 20 days seedling were shifted in the aeroponic unit

OBSERVATIONS

The following observations were recorded at seedling, vegetative and reproductive stages.

SAMPLING TIME:

Sampling was done at 20 days after transplanting, 45 days after transplanting and at harvest (80 days after transplanting).

RESULT AND DISCUSSION

The result obtained from the present investigation as well as relevant discuss have been summarized under following heads:

Relative leaf water content (RLWC %)

Relative leaf water content (RLWC %) of Kufri Badshah and Kufri Jyoti varieties with mean values at different days interval period were presented in below (Table 1 and (Fig 1) in which the significantly highest mean value found in Kufri Badshah (82.86) in T_2 (83.67). Comparatively significantly decreased mean performance was observed in Kufri Jyoti (78.38) in T_2 (79.24).

Among two varieties Kufri Badshah showed better results than Kufri Jyoti. The interactions between two varieties and treatments, the combination V_1T_2 showed as the best result compared to other combinations. Relative water content is used for evaluating plant water status because it expresses the absolute quantity of water required by the plant to achieve full artificial saturation while simultaneously representing metabolic activity in tissues. It is also the most significant measure of dehydration tolerance. RWC is associated with water intake by the roots as well as water loss through transpiration. The relative water content of both varieties of leaves decreased significantly in treatment T1(cocopeat)as shown in (Table 2) (Fig 2) due to incorrect pH, EC, and nutrients, exposing them to stress, and low water rendition capacity as compared to vermiculite + perlite. The plants grown on T2 (coco peat + vermiculite + perlite + vermicompost) had the highest RWC% because, in the aeroponic, plants decreased damages by maintaining an optimal water status. [20] supported our finding they suggest that the plant grown with cocopeat + vermiculite + perlite + vermiculite has the highest RWC % as compared to the plant grown with cocopeat only. [21] supports our findings. They demonstrated the viability of *Pisum sativum* (pea), *Abelmoschus esculentus* (okra), and Vigna radiata seedlings (moong) that grew in soil containing less relative water.

Photosynthetic pigments chlorophyll a+*b* (mg g $^{-1}$ FW):

Data represented that (Table 2) and (Fig 2) the total chlorophyll content of Kufri Badshah (2.43 mg g^{-1} FW) was significantly increased in T_2 (2.70 mg g $^{-1}$ FW) compared to Kufri Jyoti (2.17 mg g $^{-1}$ FW). The results revealed that Among interactions the highest mean found in the combination of V_1T_2. Plant growth as biomass production is a measure of net photosynthesis. Green colour, an obvious indicator of the leafy vegetable quality having a great impact on consumer preference, is associated with chlorophyll content [14]. Chlorophyll consumption as part of the human diet promotes tissue growth by serving as a chemical that promotes the multiplication of fibroblasts, which are connective tissue cells that are responsible for the healing process [15]. Different pigments are responsible for capture or absorption of different light spectrums, such as chlorophyll a and b (650-700 nm) and blue (420-460 nm) absorption bands. [16]. At reproductive stage maximum photosynthetic pigment Chlorophyll (a + b) for both varieties were shown in plants that were grown with T_2 (coco peat + vermiculite + perlite + vermicompost) and minimum were obtained from plants grown with Treatment T_1(Coco peat) as these growing media improved porosity, water holding capacity, good nutrient status, increased root growth, seedlings absorbed more nutrients like mineral ions obtained from vermiculite and vermicompost and thus produced seedlings with more growth of leaves and increased the photosynthesis pigments. These findings agree with previous findings that growth can be defined as an increase in size or volume accompanied by the production of additional protoplasmic ingredients and is enabled by the growth medium's nutritional availability. [17]. on (*Pistaciavera* L.) and [18] on papaya showed that other potential effects include delayed senescence of leaves and increase total chlorophyll in leaves and prolonged photosynthetic activity due to the high water retention capacity of the medium. [19]. Increased N supply stimulates photosynthetic capability by increasing stromal and thylakoid protein content in leaves.

Table 1: Effect of different growing media on chlorophyll a +b (mg g $^{-1}$ FW) of two different varieties of potato

chlorophyll a +b (mg g $^{-1}$ FW)								
Treatments	**Kufri Badshah**				**Kufri Jyoti**			
	Days after transplanting (DAT)				**Days after transplanting (DAT)**			
	20	**45**	**80**	**Mean**	**20**	**45**	**80**	**Mean**
T1 (Cocopeat)	2.06	2.08	2.35	**2.16**	1.89	2.08	2.21	**2.06**
T2(Cocopeat+vermiculite +Perlit+ vermicompost)	2.27	2.86	2.97	**2.70**	2.06	2.35	2.45	**2.28**
Mean	**2.16**	**1.97**	**2.07**	**2.43**	**2.66**	**2.33**	**2.50**	**2.17**
C.D. at 5%	*Variety* = 0.119 *Treatment* =0.119 *Variety x Treatment* =0.169 *DAT* =0.146 *Variety x DAT* =0.189 *Treatment x DAT* =0.189 *Variety x Treatment x DAT* =NS							

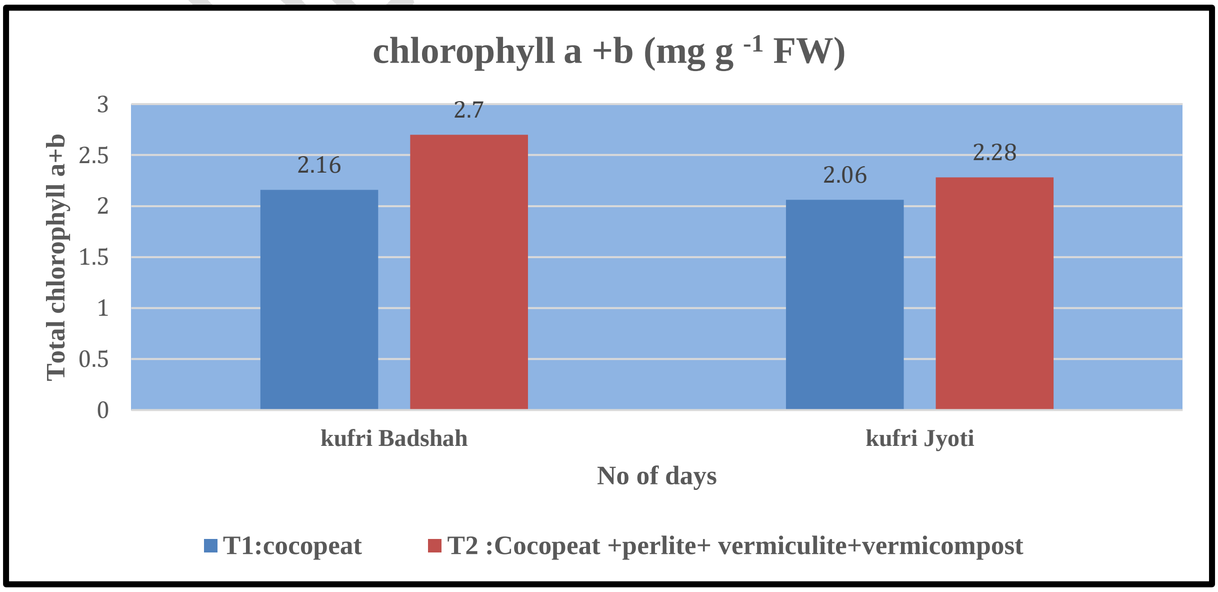

Fig. 1: Graphical presentation of showing the Effect of different growing media on chlorophyll a +b (mg g $^{-1}$ FW) of two different varieties of potato

Relative Water Content (RWC %)								
Treatments	**Kufri Badshah**				**Kufri Jyoti**			
	Days after transplanting (DAT)				**Days after transplanting (DAT)**			
	20	**45**	**80**	**Mean**	**20**	**45**	**80**	**Mean**
T1 (Cocopeat)	79.33	84.50	82.30	**82.04**	75.46	80.33	76.76	**77.52**
T2(Cocopeat + vermiculite +Perlite+ vermicompost)	80.33	86.63	84.06	**83.67**	77.76	80.63	79.33	**79.24**
Mean	**79.83**	**85.56**	**83.13**	**82.86**	**76.61**	**80.48**	**78.05**	**78.38**
C.D. at 5%	*Variety = 0.20* *Treatment =0.20* *Variety x Treatment =NS* *DAT =0.25* *Variety x DAT =0.35* *Treatment x DAT =0.35* *Variety x Treatment x DAT =0.50*							

Table 2: Effect of different growing media on relative water content (RWC %) of potato leaves

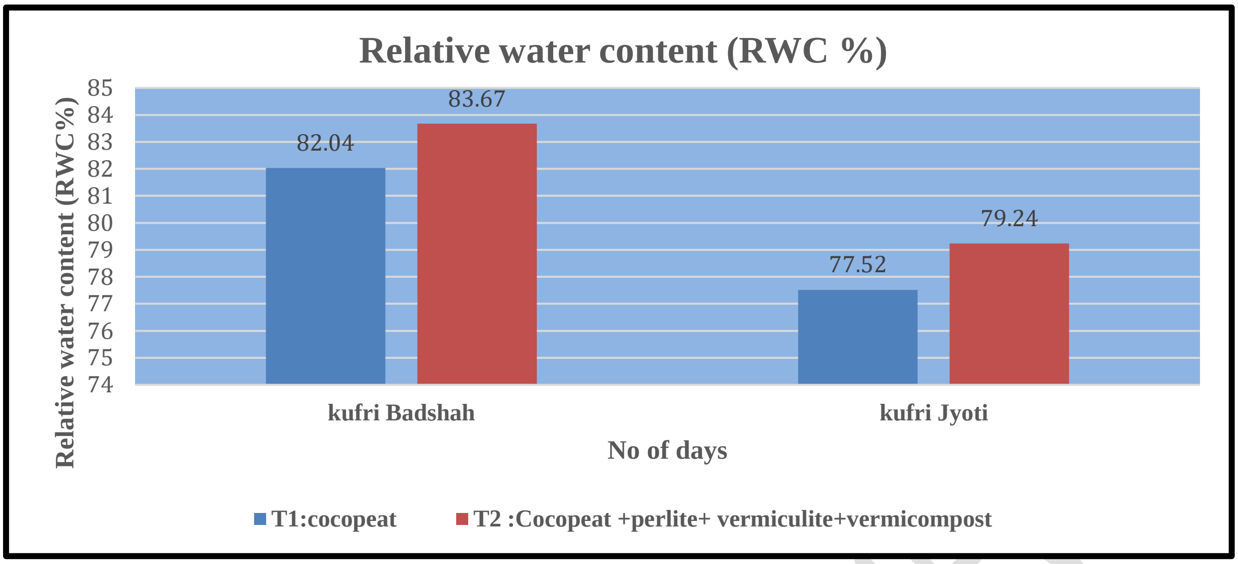

Fig. 2: Graphical presentation of showing the Effect of different growing media on relative water content (RWC %) of two different varieties of potato

CONCLUSIONS

It is concluded that the treatment (T_2) i.e. nutrient media consisting of cocopeat+ Perlite + vermiculite + vermicompost in the ratio of (2:1:1:2) found to be superior to the rest of the treatments. Regarding the issue of the non-availability of good quality seeds, methodologies to speedily multiply the seed tubers conjunction with aeroponics technology have been attempted. Application of coco peat + perlite + vermiculite + vermicompost in the ratio of 2:1:1:2 Aeroponics may be beneficial for better yield and quality production of mini tuber potato. This combination of growing media could not be recommended at this stage to farmers prior to its confirmation in the research. Nevertheless, the positive results with reference to coco peat + perlite + vermiculite + vermicompost for potato is undoubtedly encouraging for making elaborate studies in the aeroponics with right combination of growing media In the Jammu region where most of the areas have high disease and nematode pressure, the new system of seed potato production based on the soil-less system has the advantage of better health status of seed stocks due to the reduced number of field multiplications over the conventional system.

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