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A Study of Micro-Propagation of Solanum Tuberosum based on Drought Stress Tolerance

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ABSTRACT

The effects of drought acclimation in three contrasting potato genotypes ['Fv12246-6' (Fv) drought stress sensitive, 'Vigor' (V) moderately drought resistant and 'Russet Burbank' (RB) drought resistant] in a low relative humidity greenhouse were examined. Non-Acclimated and Non-Stressed (NA), Non-Acclimated and Drought Stressed (NAS), Drought Acclimated and Drought Stressed (DAS) treatments were applied. Short term acclimation had no significant long term effect on tuber weight and number under drought stress. However, water conservation mechanisms based on leaf and stem characteristics were both genotype and treatment-dependent. The importance of the stem in water conservation was revealed when leaves were drought stressed while either attached or excised from the stem. When leaves were drought stressed while attached to the stem, both the moderately and drought stress resistant genotype V and RB, respectively, maintained a higher percentage of leaf water content than the drought sensitive Fv. By contrast, when leaves were detached from the stem and moisture loss was monitored, the moderately drought resistant V genotype lost water at the fastest rate. The significantly greater stem water content of V and RB genotypes compared to Fv may have been a source of water to intact leaves during drought stress. Drought resistant RB underwent the fastest recovery from drought stress and had the highest number of drought resistance tools. Finally, compared to an application of drought stress directly (NAS), a pre-treatment of drought acclimation cycles followed by drought stress (DAS) reduced leaf wilting, induced thicker cuticular layer and more open stomata under stress. Without a DAS approach, potentially key drought stress resistance mechanisms will be missed. The role of the stem as a potential water reservoir to adapt against drought stress should be further examined to identify key elements for drought stress survival and recovery at the level of the potato whole plant.

Keywords Molecular, Micro-Propagation, Solanum Tuberosum, Stress Tolerance.

1. Introduction

Various abiotic (temperature, water, sun oriented radiation and saltiness), biotic (infection creepy crawly and weed) and physico-synthetic properties of the air and soil make noteworthy financial weight on plants. Ecological anxieties speak to the most constraining elements for horticultural efficiency in light of their adverse impacts on plant development and yield Worldwide water shortage and expanded salinization cause noteworthy harvest misfortune around the world, decreasing normal yields for most real crops by over half. Water shortfall (dry spell) and saltiness stress are winding up especially boundless in numerous districts bringing about 30% land misfortune continuously 2021 and over half by 2050. Dry spell pressure is an expanding risk to plant development and efficiency and the absolute most basic danger to world

sustenance security. Around four-tenths of the world's property surface is inside dry and semiarid zones where water is the real constraining component to plant efficiency. After wheat, rice and corn, potato is the fourth most significant sustenance crop. Potato is touchy to dry spell since its short establishes length brings about a restricted capacity to ship water. Dry season pressure influences the advancement and development of shoots, roots and tubers. Indeed, even a brief time of water lack can bring about decrease both of tuber generation and of tuber quality. Dry spell worry toward the start of the tuberization stage incited a more drawn out time of tuber arrangement and diminished tuber number, development and yield. Stolon arrangement and tuberization are the touchiest stages to dry spell pressure. Potato reaction to dry season shifts broadly among cultivars and furthermore varies with the degree and timing of water shortages. Previously and during tuber inception, soil water potential under 25 kPa influences tuber set. Endurance of, or protection from dry spell is the ability to withstand a time of dryness through evasion (keeping away from or postponing decrease of water capability of the cellular material) or resistance (when the cellular material can dry out without getting to be harmed). Portrayal of dry spell resistance in potato cultivars is confounded by the way that differential yield reactions are not reliably identified with explicit physiological or morphological attributes. In addition, a similar cultivar, for example, Russet Burbank has been described as both dry spell safe and dry spell touchy. Most utilized markers of dry season pressure obstruction are yield, leaf water substance and extracted leaf water misfortune. Leaf shrinking is the most visual reaction to dry spell pressure and in our examination; this was used as the underlying criteria for dry season pressure obstruction with Russet Burbank communicating the most elevated dry spell pressure opposition.

2. Effects of drought acclimation on drought stress:

Plants have developed various versatile reactions to conquer dry season pressure. During dry season pressure, plant water the executives involves both expanding water take-up and decreasing water misfortune. A significant part of abiotic ecological pressure is the capacity of certain plants to expand pressure obstruction after presentation to a low degree of stress (acclimation). Acclimation relies upon both the plant genotype and the earth. Albeit various sub-atomic parts of dry spell pressure obstruction components have been directed on potato, explore is inadequate in the territory of dry spell pressure opposition all in all plant and organ level which considers dry season acclimation and recuperation. Under field conditions, plants are ordinarily presented to dry spell adjusting conditions since dry season pressure gradually gathers after some time. By difference under controlled condition conditions, quick dry season stun is typically forced which doesn't consider genotypic variety for acclimation and can prompt inconceivably various reactions and may cover key reaction instruments. Besides, in spite of the fact that leaf reactions have been the focal point of most of dry season pressure examines, the stem has been to a great extent overlooked. Therefore, the general objective of this examination was to assess genotypic and acclimation-initiated dry spell pressure reactions at the entire plant and organ level in differentiating potato genotypes. Our working theory is that dry spell acclimation instigates a more noteworthy number of obstruction reactions in tolerant kinds contrasted with delicate sorts and that the stem fills in as a water supply during dry season pressure and recuperation in dry season pressure safe potato genotypes.

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3. Materials and methods

Establishment of tubers and plants

Tubers of three potato genotypes 'Energy' (V), 'Reddish brown Burbank' (RB) and 'Fv12246-60 (Fv) tubers were given by Benoit Bizimungu, potato raiser, Agriculture and Agri-Food Canada, AAFC (Fredericton, NB). Force is an enrolled cultivar that begun from a cross made among 'Agria' and 'Wischip' at AAFC, Lethbridge, Alberta. 'Agria' has medium to high dry spell opposition. Fv is an unregistered rearing clone (F72117 X ND860-2) from AAFC potato reproducing program. Clones of these germplasm utilizing the two tubers and cuttings were spread for this investigation to decide dry spell pressure obstruction under a low RH nursery condition. Tubers (50–250 g) were planted in 11 L pots with SM#4 Mix (Sunshine Mix No. 4, Sungro Horticulture Canada Limited) to simply cover the tubers. Pots were set in a nursery (day/night temperature 25/22 C, RH 50%,18 h photoperiod and light force 250–300mmol m2 s 1). At the point when shoots had arrived at 5 cm over the pot edge, various stems were diminished to a solitary primary stem and extra SM#4 Mix was added to top the pots off to 2.54 cm beneath the pot edge. Soil water content in the pots was observed by time area transmission, TDT sensors (20.5 cm length, Gro Point Lite, ESI Environmental Sensors Inc., Sidney, BC, Canada) (Sun and Young, 2001) and was kept up at or above 30%. Plants were treated two times per week (N:P:K 20:20:20, 1 g L1 for 400 ppm of nitrogen, 500 mL for every pot). Cuttings were taken from about two months old plants and at 3–4 cm beneath the shoot apical meristem of each of Fv, V and RB during September–December, 2011 in the College of Agriculture and Bioresources Greenhouses (45 Innovation Blvd., Saskatoon, SK Canada).

Drought acclimation, drought stress and recovery cycles

Cycles of Drought Acclimation, Drought Stress and Recovery periods are plot in Fig. 1. At the point when plants were around about a month and a half old, the primary Drought Acclimation cycle (first DA) was forced by retention water down to 10% soil dampness content (Fv-DAS, V-DAS and RB-DAS) and afterward re-watered to 25–35% soil water content. As of now, all NA and NAS medicines were watered to keep up 25–35% soil water content and prepared obviously. Another Drought Acclimation cycle (second DA) was forced around 5 after 7 days. The basic phases of stolon development and tuber inception compared to blossoming of the initial four blooms (information not appeared) on the potato cymose inflorescence (Huaman, 1986). At this stage, all DAS and NAS medicines were presented to the main extreme Drought Stress cycle (first DS). All NA plants were watered and treated of course. At the point when the dirt water content in the DAS and NAS pots dropped to 0%, plants were not watered until they indicated obvious shriveling (following 5–7 days, 75% leaves withered (arrange 3). Soil water substance was recorded by TDT sensors and compared to the volumetric strategy by Sun and Young (2001). A comparative relationship was additionally found in this examination (information not appeared).

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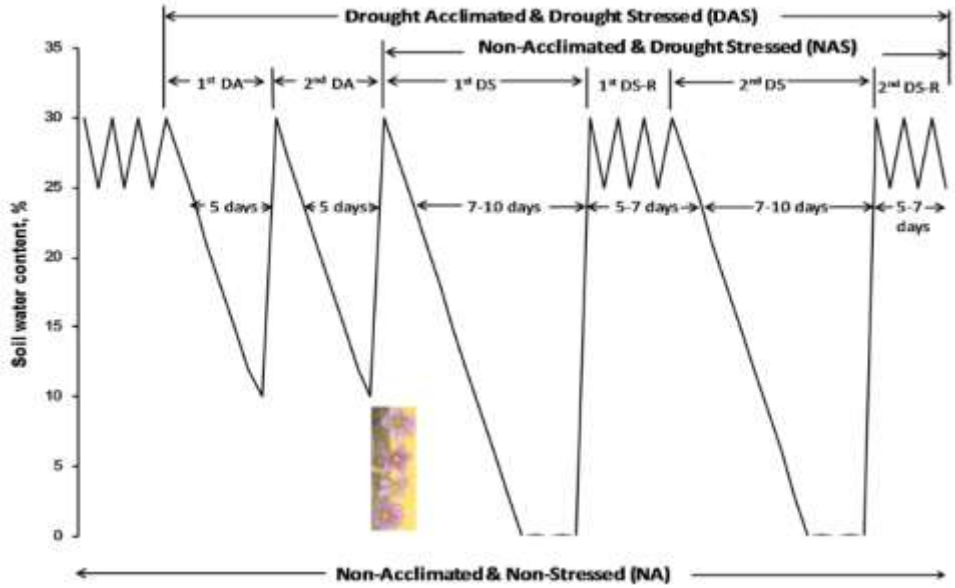

Fig. 1. Schematic diagram of applying Drought Acclimation and Drought Stress cycle

Shoot characteristics

Plant tallness was estimated from the highest point of the dirt surface to the apical meristem in all plants and medications. Last stem breadth was estimated at 2.5 cm over the dirt surface. New stem segments were then cut now in all plants and medicines. Cross segments were seen through low vacuum SEM (JSM 6010, JEOL Ltd., USA). Region of xylem and essence vessels was estimated by utilizing ArcGIS programming. Cross-sectional length of the whole xylem and substance areas was estimated oppositely from the stem border towards the focal point of the stem (ImageTool adaptation 3.0, UTHSCSA Dental Diagonostic Science, San Antonio, USA). Last stem number was recorded toward the part of the arrangement time frame when the plants were over a quarter of a year old. Shoots (stem and leaf) of all plants were then set in a drying room at 40 C and information recorded when steady weight was come to.

4. Results

Tuber weight and number

Tuber weight was estimated as the absolute mean tuber mass per pot. Despite the fact that true to form, dry season pressure medications (DAS, NAS) induced lower mean tuber weight, variety was high and there was no huge impact on weight (Fig. 2(a)). Paradoxically, there was a genotype-subordinate reaction when pooled crosswise over medicines in that RB had higher ($p < 0.05$) tuber weight than Fv (Fig. 2a). Likewise, V had the most noteworthy mean complete tuber number per pot (Fig. 2(b)). Moreover, partition of all out mean tuber number into explicit weight classes uncovered the huge commitment of the littlest weight class (<5 g) to the V reaction (Fig. 2(c)). RB communicated lower quantities of modest tubers in this weight class however increasingly huge tubers in the 50–100 g classification contrasted with V (Fig. 2(c)) and was the fundamental contributing element to RB's higher tuber weight (more prominent mean mass per pot).

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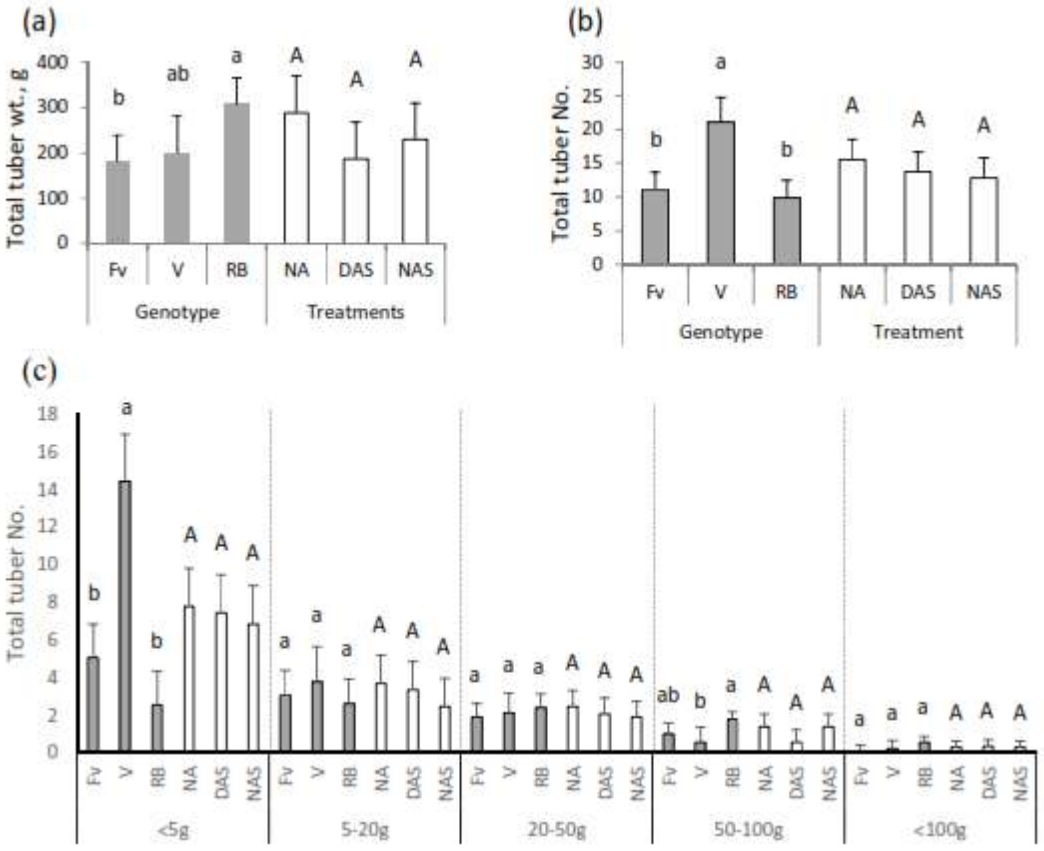

Fig. 2. (a) Tuber weight (g/pot), (b) tuber number/pot and (c) tuber number/pot across different weight classes in potato genotypes Fv, V and RB (grey bars) and treatments [Non-Acclimated and Non-Stressed (NA), Drought Acclimated and Drought Stressed (DAS) and Non-Acclimated and Drought Stressed (NAS), white bars]. Vertical lines are SE at 95% CI. Groups having different letters are significantly different

Drought stress application to intact leaves on stems

Leaf shriveling is the most visual record of dry season pressure. Dry season Acclimation diminished ($p < 0.05$) leaf withering under dry spell worry in the RB genotype yet not in the Fv genotype (Fig. 3). Dry season acclimation itself didn't lessen %LWC of Fv contrasted with RB and V, yet consequent presentation to serious dry season pressure (first and second DS) reduced %LWC of Fv contrasted with RB and V, individually (Fig. 4(a). Fv was commonly progressively touchy to dry spell pressure contrasted with RB and V. Dissimilar to visual leaf withering, estimation of % LWC didn't recognize an acclimation impact under dry season worry in RB or when pooled crosswise over genotypes. Additionally, while the %LWC was decreased in dry season focused on plants at the first worry, by the second dry spell pressure, %LWC expanded in the DAS and NAS treated plants to equal estimations of the NA control.

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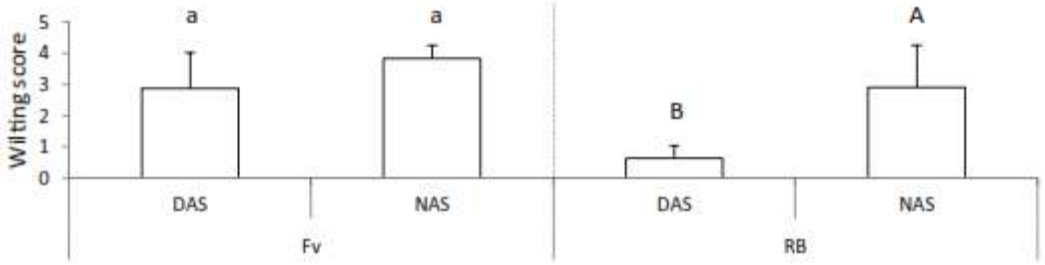

Fig. 3. Leaf wilting score (0 = 0% leaf wilting to 5 = 100% leaf + stem wilting) in potato genotypes Fv and RB and treatments [Drought-Acclimated and Drought Stressed (DAS) and Non-Acclimated and Drought Stressed (NAS)] under drought stress. Vertical lines are SE at 95% CI. Groups having different letters are significantly different

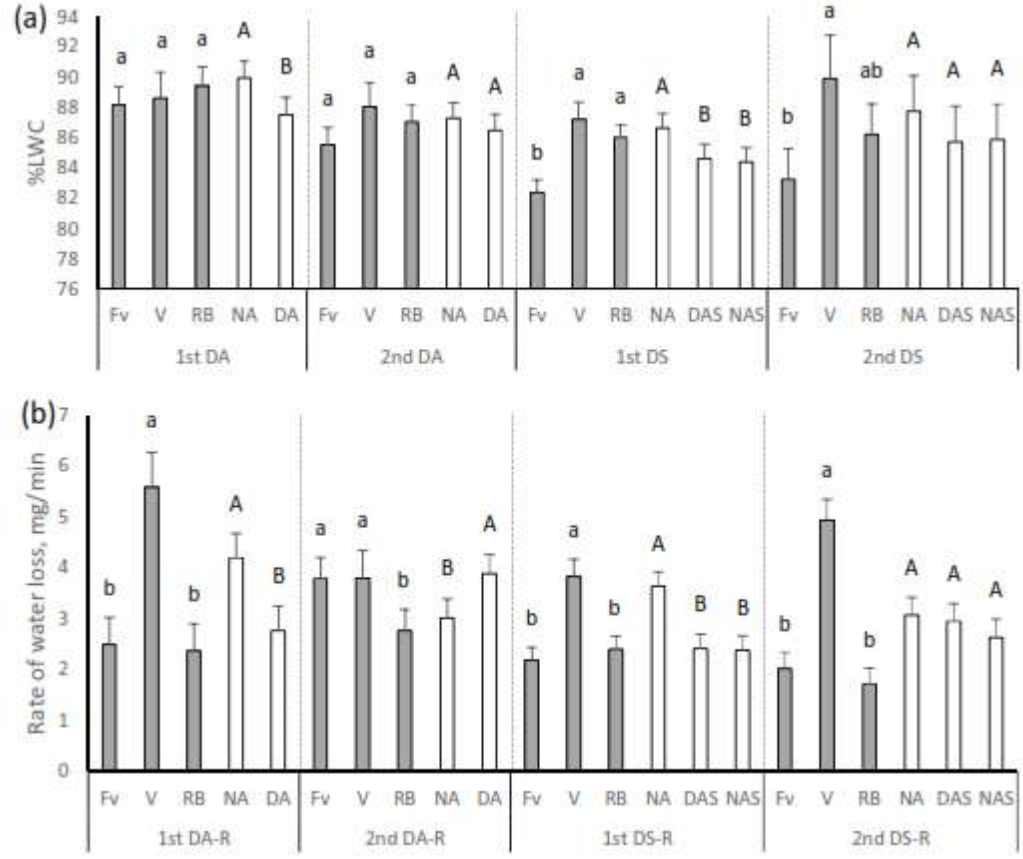

Fig. 4. Leaf water content (%LWC) and (b) rate of water loss from leaf surface over 15 min in potato genotypes Fv, V and RB (grey bars) and treatments [Non-Acclimated and Non-Stressed (NA), Drought Acclimated and Drought Stressed (DAS) and Non-Acclimated and Drought Stressed (NAS), white bars]. (a) after Drought Acclimation (1st and 2nd DA) and Drought Stress (1st and 2nd DS) cycles, (b) during Recovery after both Acclimation (1st and 2nd DA-R) and Drought Stress (1st and 2nd DS-R).

Drought stress application to excised leaves

Dry spell stun forced by extraction of bloated leaves after Recovery (R) from two cycles of Drought Acclimation (DA) and two cycles of Drought Stress (DS) uncovered contrasts among genotypes and medications (Fig. 4(b)). Be that as it may, these distinctions relied on timing of the dry spell

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stun. At the point when dry season stun was forced after Recovery from the first DA (first DA-R), the accustomed germplasm (DA) lost dampness at a lower rate ($p < 0.05$) than the Non-Acclimated germplasm (NA) in any case, during the second DAR, DA had a higher pace of dampness misfortune than the NA treated germplasm. At the point when dry season stun was applied after Recovery from the first DS (first DS-R), both Drought-Acclimated and Drought Stressed (DAS) and Non-Acclimated and Drought Stressed (NAS) germplasms had a lower pace of dampness misfortune from extracted leaves contrasted with Non-Acclimated Controls (NA). Anyway upon Recovery following a subsequent Drought Stress (second DS-R), dry spell acclimation didn't change the pace of leaf dampness misfortune (DAS versus NAS). Under dry season stun, genotype V showed the most elevated pace of dampness misfortune contrasted with different genotypes all things considered inspecting times.

5. Discussion

In this examination, momentary acclimation had no noteworthy long haul impact on tuber number and tuber weight reactions to dry spell pressure. Tuber number and weight per fundamental stem were not impacted by Drought Acclimation or Stress. A huge scale explore different avenues regarding a more noteworthy number of perceptions is prescribed since the variety was high. Pooled information from each of the three medicines (NA, DAS and NAS) showed a genotype-subordinate reaction with the end goal that RB had higher quantities of huge tubers (50–100 g) and had more prominent weight (all out tuber mass per pot) than Fv over all medications. On the other hand, V had the most elevated tuber number with progressively small tubers (<5 g). The higher tuber number of genotype V in the<5 g class was steady crosswise over NA, DAS and NAS medications of this genotype. Phase of improvement when pushed might be the most critical factor deciding yield reactions crosswise over cultivars. Since RB was late developing while Fv and V had a comparable formative rate, Fv and V were worried at a similar tuber inception organize, viewed as the most basic dry spell pressure arrange. Despite the fact that V and Fv were worried at a similar phase of advancement, there was a differential reaction in tuber number yet not in tuber weight between these two genotypes. In this way, tuber number was a more touchy file of genotype reaction than tuber weight in that V had the most astounding tuber number over the medicines and tuber number was fundamentally diminished in Fv over these equivalent conditions. Tuber number is impacted by seed tuber qualities and number of stolons per stem. In addition, there was no distinction in tuber weight among V and Fv which further demonstrates tuber number to be a more touchy list than tuber weight to recognize these two genotypes. Portrayal of dry spell resilience in potato cultivars is entangled by the way that differential tuber weight reactions have not been reliably identified with explicit physiological or morphological qualities. The markers most used to gauge dry season pressure obstruction are yield, leaf water substance and extracted leaf water misfortune. Plant water the executives is a mix of expanding water take-up and diminishing water misfortune during dry spell pressure and is of evident significance. While this investigation didn't look at water take-up instruments, parameters identified with decreasing water misfortune were assessed.

6. Conclusion

weight and number were genotype-subordinate and keeping in mind that transient dry season acclimation didn't seem to have a critical long haul impact on expanding these qualities under dry spell worry in our investigations, these tests ought to be rehashed, especially under field conditions. Be that as it may, water preservation systems dependent on leaf and stem qualities were both genotype and treatment-subordinate. Modestly dry season pressure safe genotype V kept up a higher level of leaf water content (% LWC) than dry spell pressure touchy genotype Fv conceivably through a system of water supply from water put away in the stem and conveyed through proceeded with leaf transpiration under dry season pressure. Dry spell pressure safe genotype RB likewise had higher %LWC than Fv, and its component of water preservation seems to have included an apparatus like that of V: higher rate stem water content (%SWC) and a proceeded with stock of water through the transpiration stream by means of open stomata under pressure. Further, RB had more dry spell pressure opposition instruments: a comparable xylem to substance proportion and water misfortune from the stem which may have improved the quickest leaf recuperation from dry season pressure. Fv was the most delicate potato genotype, showing the most astounding level of leaf shrinking and least %LWC under dry spell pressure. It had minimal number of dry season pressure obstruction devices: littler stomata and conclusion under dry spell stun, and an acclimation-initiated thicker cuticular layer. Fv likewise had the most reduced %SWC and the slowest recuperation time after dry spell pressure.

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