Study of Morphology and Physiology of Rice Seed IR Variety 42 (Oryza Sativa L) against aged moving with the SRI (The System of Rice Intensification) Method

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Abstract— *Germination is one of the main processes in plant development, where the age of seedling greatly influences the success of the process. The purpose of this study was to determine the morphological and physiological changes of rice seeds in various seedling transplants in the SRI method. The study began from September to October 2018 at the Andalas University Seed and Plant Physiology Laboratory and the Agricultural Product Technology Laboratory of the Andalas University. This study uses a Completely Randomized Design, where the treatments are 0 days of seedlings, 7 days of seedlings and 14 days of seedlings. The difference in radicle length and grain weight difference for each age moved by IR 42 seedlings SRI method.moving seeds can change the morphology of seeds from seed that looks dull marked by the presence of brown spots becoming fresh, shiny, but there are still a few brown spots. Changes in physiology of the age of IR 42 seedlings moving SRI method, the changes that occur is a decrease in the protein content of seedling age 0 days and 7 days after germination from 2.2181% to 0.8356% for four times the analysis process was carried out and the age of seedling 7 days after germination from 1.303% to 1.2588% for two times the analysis process was carried out, then there was a decrease in the content of starch analysis of seedling age 0 days and 7 days after germination from 15.4546% to 10.2812% for four times the analysis process carried out and the age of seedling transplants 7 days after germination from 11.9816% to 7.6806% for two times the analysis process was carried out, then there was a decrease in sugar content analysis of seedling age 0 days and 7 days after germination from 0.0771% to 0% for three times the analysis process was carried out and the age of seedling 7 days after germination was 0%.*

Keyword— *endosperm, physiology, morphology, age of seedling, SRI method.*

I. INTRODUCTION

Rice (Oryza sativa L.) is an important food crop that has become a staple food for more than half of the world's population. In Indonesia, rice is the main commodity in supporting community food. Indonesia as a country with a large population faces challenges in meeting the food needs of the population. Therefore, food security policies are the main focus in agricultural development. Rice consumption in 2011 reached 139 kg capita-1 year-1 with a population of 237 million people, so that national rice consumption in 2011 reached 34 million tons. The need for rice continues to increase along with the rate of population growth which is faster than the growth of available food production, (BPS, 2011)

The obstacles and challenges faced in realizing national food security are competition in the use of land and water resources. Conversion of agricultural land for non-agricultural activities, especially in Java, causing agricultural production to decline. In this case, the agricultural sector faces challenges to improve efficiency and optimize the use of land resources. The increase can be done by increasing crop efficiency through the regulation of the planting system and streamlining the age of seedlings in nurseries. Setting the planting system and age of the right seeds, and the use of

superior varieties of rice in addition to being effective in plant growth are also efficient in time and get optimal productivity.

To get the optimal level of production, seed is one of the most influential technological components. According to Kamil (1982), seedlings are young plants that are crucial for subsequent plant growth. One effort to achieve the above target is through an intensification program by applying appropriate production technologies and the use of efficient and profitable production facilities, including technology for the use of the number of seeds per family.

According to Djafar (2002), seedlings are one of the important factors in rice cultivation. Seedlings from superior varieties with good management from an early age will be able to face obstacles and competition in the field, so that they can produce high production. The quality of seeds planted is influenced by the age of seedlings planted before planting. The right age of seeds is one of the technologies that can determine rice production. According to De Datta (2000), transplanting seedlings at a younger age can reduce seedling damage, plants do not experience stagnation and plant growth is faster.

The use of rice seeds that are around 30 days old will give unfavorable results, because the seeds used are relatively old so they are slow to adapt to the environment, have non-uniform tillers, shallow roots and subsequently plant growth is imperfect (Abdullah et al., 2000) . While young seedlings adapt more quickly to the environment, forming deeper roots, so the plants are more resistant to lodging, drought tolerant, and able to utilize nutrients more effectively (Guswara and Kartaatmadja, 2001).

The age of transplanting seedlings must be appropriate to anticipate root development which generally stops at 42 days after seedling, while the number of productive tillers will reach a maximum at 49-50 days after seedling (Astri, 2007). Planting young seedlings has several advantages, among others, plants can grow better with a higher number of tillers and seedlings aged less than 15 days faster adapt and recover quickly from stress due to being moved from the nursery to the planted land (BPTP Jambi, 2009).

Kuswari and Alit (2003) The system of rice intensification (SRI) is a rice cultivation technique that is able to increase rice productivity by changing the management of plants, soil, water, and nutrients, proven to have succeeded in increasing rice productivity by 50% even in some places reach more than 100%. At this time no one has explained how the morphological and physiological changes in transferring rice seeds by SRI, in general, the planting system and age of seedlings in lowland rice plants are known to affect the growth and yield of lowland rice. Therefore this study was conducted by looking at the morphological and physiological changes of various ages moving the seeds of the SRI method.

II.   RESEARCH METHODS

This research was conducted at the Seed Technology Science Laboratory, Faculty of Agriculture and the Agricultural Product Technology Laboratory of Andalas University. This research was conducted in September to October 2018.

The tools used in this study were, spectrophotometer, test tube stirrer, sparayer, stationery, paper labels. The materials to be used in this study are IR 42 rice seed varieties, paddy soil, plastic bottles, rubbing ash, aquades, soil, sand, Al (OH) 3, Aquadest, Na2CO3, K, boiling stones, luff-schoorl, KI 20 %, H2SO4 26.5%, Na-thiosulfate, H2SO4 (93-98% free N), Na2SO4-HgO (20: 1), NaOH-Na2S2O3, zinc, boric acid, methylene blue, HCl, erther, NaOH 45% , 70% alcohol, 96% and 100%, formalin, glacial acetic acid, xylol I, xylol II, xylol III, xylol IV, paraffin, safranin, and fastgreen.

This study uses descriptive methods and experimental methods. Descriptive method is used based on changes in seed anatomy. The experimental method is used based on observing physiological changes. This research was conducted in the form of a complete randomized design trial consisting of one factor with three replications. Factors in the experiment were the age of the seeds consisting of 3 treatments, namely:

A1 = 0 nursery days

A2 = 7 nursery days

A3 = 14 nursery days

In this study using 3 plastic cups (making it easier in the extraction process) each treatment so that there are 27 plastic cups for all experimental units. The data obtained were analyzed by analysis of variance. If the F calculated treatment is greater than the F table of 5%, it is followed by further Duncant Multiple Range Test (DNMRT) tests at the 5% significance level.

III.   RESULTS AND DISCUSSION

Based on variance at the 5% level of seedling age treatment of IR 42 varieties the SRI method had a significantly different effect on the length of the radicles. These significant differences can be seen in Table 1 below.

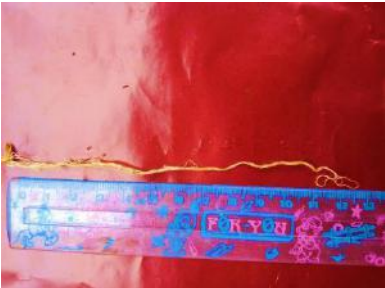*Table 1.Radicula lengths of some age-old transplanted S 42 IRS seedlings at 14 days after germination.*

Seedling Age (Day)	Radicular Length (cm)
0	0 a
7	8,33 b
14	13,67 c
KK = 16,55%	

Based on the table above, it can be seen that the 14-day moving age shows radicle length (13.67 cm), significantly different from the 7-day treatment (8.33 cm), as well as the 0-day seed transfer age with an average (0 cm)). This is thought to be due to the availability of food substances in the endosperm that have been decomposed so that one of them occurs root elongation and leaf formation, This is in accordance with the opinion of Sutopo, (1993). That the stage of growth and development of sprouts is very dependent on the availability of food substances in endosperm. This is what causes the difference in root length in each seedling age treatment because of the longer days of seedling moving age, then the root length will increase as the availability of nutrients in the endosperm decreases.

Rice plants have the type of hypogeal germination in which the appearance of radicles is followed by elongation of the plumula, the hypocotyl does not extend above the soil surface while the cotyledons are in the seed coat below the soil surface. The cotyledons here, called scutellum, remain in the soil. According to Kuswanto, (1996).Scutellum functions as an organ that absorbs food from the endosperm and delivers it to the developing embryonic axis.

Table 2. Radicular length in various treatments

Age moved seedlings	Radicular Length (cm)	information
Day 0		The seeds have not yet released radicles
Day 7		The seeds have issued radicles with an average length of 8-10 cm.
Day 14		The seeds have secreted radicles with an average length of 10-15 cm.

During the germination process, the first thing to come out is the radicles. Furthermore, in these radicles outgoing lateral roots, together with the primary roots form the primary root system. This primary root system usually only functions for a while, and then dies. The function of the primary root system is then replaced by adventitious roots coming out of the first stem node and some of the overlying nodes. This adventitious root system (root fibers) is what guarantees subsequent plant life in terms of absorption of water and food from the soil and as a fixing device on the soil.

Germination will occur in the temperature range of 10 0C to 40 0C when the seed dormancy can be solved and the seeds absorb enough water (Yoshida, 1981). According to Salisbury (1985) embryonic axis growth occurs because of two events namely enlargement of existing cells and the formation of new cells at the point of growth of the radicles and plumules due to cell division. An increase in air temperature above the optimum limit will reduce root growth and nitrogen fixation which will cause low rice production (Prasad et al., 2000).

Protein Analysis

Based on the analysis of proteins that have been carried out at various ages moved seedlings IR 42 varieties in the SRI method can be seen in Figures 1 and 2 below.
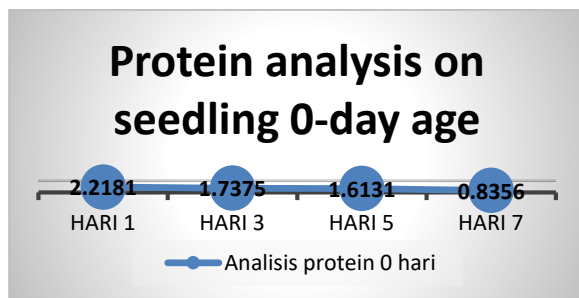
Fig.1.Analysis of age protein of 0 day seedling IR 42 variety in the SRI method.
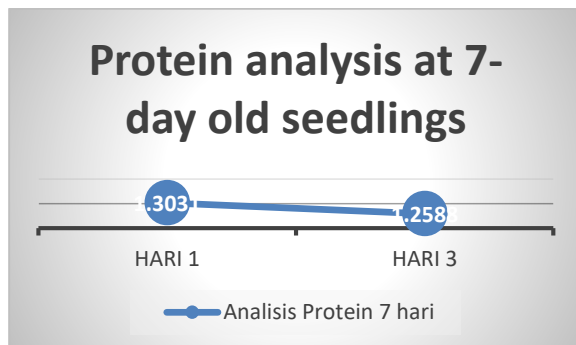

Fig.2. Protein analysis at 7 days old age of IR 42 seedling varieties using the SRI method

0 days age showed a protein content of 2.2181% for the first observation, then the observation was returned on the third day there was a decrease in protein content to 1.7375%, then on the 5th day observation the protein content decreased to 1.6131%, and the following day 7 protein content left only 0.8356%. Based on protein analysis that has been done on IR 42 rice varieties for 7-day nursery age, it was found that 1.3031% protein content, then again the protein content analysis on the third day decreased to 1.2588%. . Then for 14 days of IR 42 rice varieties were not carried out at all because there was no protein content remaining.

The amylase enzyme germinates to break down flour into maltose and maltose is hydrolyzed by maltase to glucose. Proteins are also broken down into amino acids. Then glucose compounds enter the metabolic process to produce energy or are converted into carbohydrate compounds that make up the structure of the body- Amino acids are assembled into proteins that function to structure cells and form new enzymes. Fatty acids are mainly used to make cell membranes. (Dwidjoseputro, 1983).

Protein is one of the main and important food reserves that accumulates in high amounts during the second stage of seed development, namely the mid-maturation stage, after the development of the zygote and before drying. Most of the protein is related to primary metabolism, which indicates a great need for this material for embryonic growth. Protein also plays an important role during seed development, is involved in the metabolism of sugars which provide a carbon source, and also in various biochemical activities of seeds (Li et al., 2012).

Transcription is the process of DNA replication to form RNA-d. Meanwhile, translation is the process of translating genetic information contained in RNA-d into a polypeptide amino acid sequence. In transcription, DNA is used as a model for protein synthesis.

Senthil and Gowri (2008) stated that rice seeds consist of endosperm and embryos, where embryos consist of plumules (leaf candidates) and radicles (primary root candidates). Rice seeds are orthodox seeds covered by palea and lemma (Manurung and Ismunadji, 1988). Protein is stored in the body of protein. The process of division and enlargement of cells depends on the formation of energy and growth component molecules originating from the food supply network.

Protein and fat molecules are important for protoplasmic growth, while complex molecules of polysaccharides and polyuronic acids for the formation of cell walls. Decomposition of the protein available in endosperm is what causes protein content to decrease. In general, there is a sudden increase in protein content that occurs within a few days during the period of cell expansion (Mandal and Mandal, 2000).

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Most proteins are not active in seed metabolism and only function as food reserves to be used in embryo growth during germination. Only a small percentage of proteins are metabolically active, but they are very important for seed development and germination, which is to play a role in catalysis in all digestive metabolic processes, translocation, and utilization of food reserves, and all growth activities (Copelend, 1976).

Rice seed protein is a food reserve, so it will be mobilized during germination. Mobilization of protein in germinated seeds is associated with increased activity of protease enzymes that degrade proteins (Bewley and Black, 1983).. Protease enzymes are classified into endopeptidase and exopeptidase enzymes consisting of aminopeptidase and carboxypeptodase. Degradation of the protein catalyzed by the exopeptidase enzyme produces free amino acids, whereas endopeptidase produces a shorter peptide chain, then this peptide is further degraded by peptide hydrolase to free amino acids (Bewley and Black, 1983).

Albumin and globulin are the main constituents of seed protein reserves in dicotyledonous plants, whereas in monocotyledonous plants the main proteins are prolamins and glutelins (Mandal and Mandal, 2000). Proteins in seeds can be distinguished from other proteins, for example: (i) accumulating high amounts in seeds during the middle stages of ripening the seeds and used during germination; (ii) synthesized only in seeds (in cotyledons or endosperm) not in other tissues; (iii) has no other functional activity aside from being a food reserve; (iv) stored mainly in special storage organelles called protein bodies (Mandal and Mandal, 2000). The protein reserves in the seeds are synthesized mainly from photoasimylates in the form of sugars and from amino acids (Borek et al., 2009).

Starch Content Analysis

Based on the analysis of starch content that has been carried out at various ages moved seed IR 42 varieties in the SRI method can be seen in Figures 3 and 4 below.

Based on observations of the analysis of the content of starch content in IR 42 rice varieties for the age of 0 day seedlings were found 15.4546% for the first day analyzed, then the third day the analysis was conducted again found the results of a decrease in starch levels of 13.7199%, then the analysis was carried out again on the fifth day there was a decrease in starch content of 10.4704%, then on the seventh day a starch content analysis of IR 42 rice varieties was returned in 10.2812%.
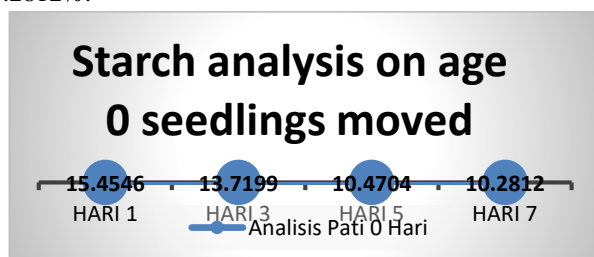

Fig.3.Analysis of starch content at 0 days old age of IR 42 seedling in the SRI method.
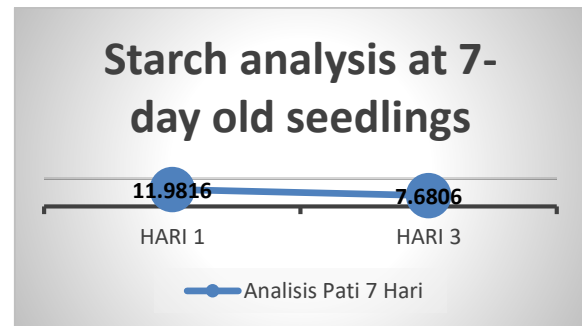

Fig.4.Analysis of protein in 7 days old age of IR 42 variety seedlings in the SRI method.

Based on observations of starch content analysis for 7 days nursery age found 11.9816% for the first day of analysis and re-analysis on the third day found the remaining starch content of 7, 6806%, the analysis process was stopped not carried out again, this is suspected not so much residual starch content is stored if it is associated with an analysis of protein content. This is in line with the process of analyzing starch content for the age of 14 days, the analysis process is not done at all because we also suspect the remaining content of starch can be seen at the age of the nursery 0 days and seven 7 days.

A decrease in food reserves can cause the substrate for respiration to decrease so that the energy obtained is not enough to carry out the physiological germination process. The ability of seeds in an effort to maintain food reserves (carbohydrates) causes the seeds can still store an energy supply that will be used by embryos to grow and develop.

In seeds, starch consists of two forms, namely amylopectin and amylose. The alpha amylase enzyme will break down amylopectin and amylose into dextrin, then the enzyme glucoamylase will convert dextrins into simple sugars such as maltose and glucose which will be used as fuel for respiration.

Decrease in seed starch content will be accompanied by an increase in grain weight. This can occur because a decrease in starch content is a series of catabolism associated with respiration in terms of providing energy and food reserves for seed growth. After the absorption of water by the seeds, growth enzymes become active.

According to Forgarty (1983) Carbohydrate overhaul carried out by the enzyme amylase from Aspergillus is also important for the growth of bacteria and

yeast when soybeans undergo fermentation in salt solutions. A-amylase and glucoamylase are enzymes that have a role in the process of overhauling carbohydrates or starches. The α-amylase enzyme catalyzes the breakdown of the glycosidic α-1.4 bond from the starch molecule, while glucoamylase or amyloglucosidase hydrolyzes the α-1,4 and α-1,6 glycosidic bonds from the ends of the non-reducing sugar sequentially.

The alpha amylase and glucoamylase enzymes hydrolyze starch to glucose which has a simpler structure. These materials after overhauled then partly used directly as a constituent of growth in growth spots including growth at the root ends of the seeds. The main carbohydrates in rice are starch and only a small portion of starch, cellulose, hemicellulose, and sugar. Rice starch ranges from 85 - 90% of the dry weight of rice.

The quantity of starch decomposes in endosperm tissue by amylase is much greater than with phosphorylase, this shows the more important role of an-amylase in the breakdown of starch reserves in germination of rice seeds, it can be said that α-amylase is the main enzyme responsible for changes carbohydrate pattern in the seed after 4 days of germination.

Starch is the main source of carbohydrates in food in the form of polysaccharides stored in plant tissues, in the form of granules in leaf chloroplasts and in amyloplasts in seeds and tubers (Sajilata et al., 2006). Starch is a homopolymer composed of lots of glucose with glycosidic bonds. The glycosidic bond is a bond that joins two monosaccharides to form a disaccharide. Starch is composed of amylose which is a straight chain polymer and amylopectin which is a branched chain structure (BeMiller and Whistler, 2009). Amylase is a starch degrading enzyme that can be grouped into three enzyme groups, namely α-amylase, β-amylase, and glucoamylase. β-amylase (E.C 3.2.1.2) is an enzyme of the hydrolase group used in the process of saccharification of starch (a type of carbohydrate). Saccharification plays a large role in the breakdown of carbohydrate macromolecules.

The breakdown of carbohydrate macromolecules will produce short-chain (simple) carbohydrate molecules. The β-amylase enzyme is also called α-l, 4-glucan maltohydrolase E.C. 3.2.1.2. because it works on the α-1,4-glycosidic bond by inversing the configuration of the position of the number 1 C atom of the glucose molecule from α to β. This enzyme breaks the amylose and amylopectin bonds from outside the molecule and produces maltose from the non-reducing end of the polysaccharide chain. In the α-1,6glycosidic bond the activity of this enzyme will stop (Sadikin 2002). The main carbohydrates in rice are starch and only a small

portion of starch, cellulose, hemicellulose, and sugar. Rice starch ranges from 85 - 90% of the dry weight of rice. The content of pentosan ranges from 2 - 2.5% and sugar 0.6 - 1.4% from broken skin rice (Winarno, 1997). Starch is composed of amylose which is a straight chain polymer and amylopectin which is a branched chain structure (BeMiller and Whistler, 2009).

Rice starch is composed of two carbohydrate polymers, namely amylose and amylopectin. Amylose is a starch with unbranched chemical structure and is a water-soluble fraction, while amylopectin is a starch with branched chemical structure, is insoluble in water, and tends to be sticky compared to the chemical properties of amylose (Haryadi, 2008).

Sugar Content Analysis

Based on the analysis of sugar content that has been carried out at various ages moved the seedlings IR 42 varieties in the SRI method can be seen in Figures 5 and 6 below.
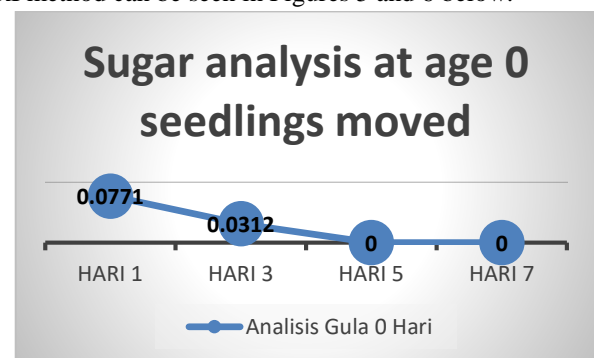

Fig.5.Analysis of sugar content at 0 day age seedlings IR 42 variety on the SRI method.
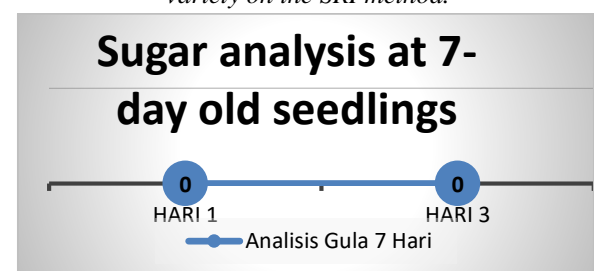

Fig.6.Analysis of sugar content at 7 days old seedling IR 42 variety on the SRI method.

Based on observations of the analysis of sugar content in IR 42 rice varieties for 0 day nursery age obtained 0.771% results for the first day of analysis, then on the third day there was a decrease in the remaining sugar content to 0.0312%, then on the fifth day the remaining sugar content remained only 0 %, so the analysis process is stopped because there are no more residual sugar content left.

Based on the observation of the process of sugar content analysis in IR 42 rice varieties for 7 days nursery age, the residual sugar content was found to be only 0%, then the third day carried out the same process remaining 0% sugar content, so looking at the process of sugar content analysis not done anymore, along with this for the age of the 14th anniversary not done at all because not yet until the age of 14 days the remaining sugar content is no longer stored. In the process of digestion of seeds needed enzymes that function in turning starch into sugar (Kamil, 1979). During the age analysis process the rice seedlings moved along with reduced sugar content and reduced starch content in the seeds.

Sugar is a carbohydrate component found in seeds that has a defense against decreasing water content as well as protein. If there is a drying process due to water loss can be replaced by the presence of sugar contained in starch, because this can prevent membrane leakage by forming intracellular glass so that the solution becomes concentrated and the diffusion process can be blocked (Adimargono, 1997) The process of respiration as a catabolism process will break down food reserves in the seed that is converting glucose into energy needed by seeds to grow. After the seeds have absorbed water, the seed coat membrane will be permeable to allow oxygen absorption. Oxygen is used in the process of burning glucose.

The enzyme composition needed for the synthesis of sucrose from glucose, namely, hexokinase, phosphoglucoisomerase, phosphoglucomutase, UDP-glucose pyrophosphoryl-ase, sucrose synthetase and UDP-ATP-kinase. So that glucose from endosperm is synthesized into sucrose, by amylolytic activity and mobilized to the scutellum. Then, it is then transported to the embryonic axis, that is, the candidate bud and root candidate, for further metabolic purposes.

Hydrolysis is a decomposition reaction between a compound with water so that the compound breaks or breaks down (Kurniasih, et al., 2011). The more effective hydrolysis, the more glucose is produced (Arianie and Idiawati, 2010). Following this, the starch hydrolysis reaction forms glucose.

IV. CONCLUSIONS AND RECOMMENDATIONS

The results of research that has been carried out on the age of moving IR 42 seedlings using the SRI method are:

1. The difference in radicular length for each age of transfer of IR 42 seedlings in the SRI method.
2. There was a physiological change in the age of IR 42 seedlings moving SRI method, the change that occurred was a decrease in the protein content of seedling age 0

days and 7 days after germination from 2.2181% to 0.8356% for four times the analysis process was carried out and the age of transplanting seedlings 7 days after germination from 1.303% to 1.2588% for two times the analysis process was carried out, then there was a decrease in the content of starch analysis of seedling age 0 days and 7 days after germination from 15.4546% to 10.2812% for four times the analysis process was carried out and the age of seedling moved 7 days after germination from 11.9816% to 7.6806% for two times the analysis process was carried out, then there was a decrease in the content of sugar analysis of seedling age 0 days and 7 days after germination from 0.0771% to 0% for three times the analysis process was carried out and the age of seedling 7 days after germination was 0%.

3. Seedling age 14 analysis cannot be carried out because there is no longer stored protein content, starch content and sugar content to be able to be analyzed.

V. SUGGESTION

From the research that has been done it is advisable to use the age of moving seeds 7 days to 12 days, because the protein content, starch content, sugar content can still be stored in food reserves.

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