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Determination of Optimum Spacing and Transplanting Age for Saro5 (TXD 306) Rice Variety Under System of Rice Intensification in Mvumi-Kilosa, Tanzania

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***Abstract*: In the determination of optimum age and spacing on yield and yield components of SARO rice variety, an experiment in split plot format based on randomized complete block design with 3 replications was conducted. Factors of Experiment consisted of three levels namely seedling ages (10, 12 and 14 days after emergency) and three levels of spacing (20×20, 25×25 and 30×30) cm. The results showed that a combination of 10 days aged seedlings spaced at 25 cm x 25 cm resulted into the highest number of total tillers, number of productive tillers, he quantity of grain yield, the quantity of shelled paddy as well as the shelling percentage, while a combination of 14 DAE spaced at 20 cm x 20 cm resulted into the lowest of all mentioned parameters. The seedlings of 12 DAE spaced at 20 cm x 20 cm resulted into the plants with the highest height compared to other age –spacing combination, while the seedlings of 14 DAE spaced at 30 cm x 30 cm resulted into the lowest plant height. This means that the experimental plots which resulted into the highest shelling percentage had low percentage of rice husks while the plots resulted into low shelling percentage had high percentage of rice husks. The biomass produced was highest in the seedlings of 10 DAE with 25 cm x 25 cm which might be attributed to the large number of total tillers produced. Therefore, the combination of 10 aged rice seedlings at the spacing of 25 cm x 25 cm has been recorded to result into the highest yield and yield components for Mvumi area in Kilosa District.**

***Keywords*: conventional practices, optimal spacing, management practices, transplanting age, system of rice intensification, TXD 306, rice.**

1. Introduction

Rice is one of the leading food crops in the world, it feeds one half of the world's population particularly in Asia, where approximately 90% of world's rice is produced and consumed (Zeigler and Barclay, 2008) because of its favorable warm and humid climate. Rice is grown in a wide range of soil types and water regimes; irrigated, rain fed lowland, upland and flood prone areas but the principles of land preparation, planting, management harvesting and finally processing are similar through the world (Artacho et al., 2009). Global rice production which dropped at the beginning of the 21st century, from 410 million tons in 2000 to 378 million tons in 2003 because of severe droughts, has recovered by growing 50 million tons between 2005 and 2011 and tripled in the last five decades from 150 million tons in 1960 to 450 million tons in 2011 (Rejesus,2012) due to the introduction of more than 1000 high yielding rice varieties by the International Rice Research Institute (IRRI) and global rice production which dropped sharply at the beginning of the 21st century (Balagtas *et al.*, 2012).

In Africa, the economic importance of rice has increased due to the increase of the imported amount which has more than doubled due to increase in food diversification, immigration, and gradual evolution in the nutritional habits of many Africans, especially those living in the urban areas who have changed from eating only traditional foods, such as cassava, millet and sorghum to rice and wheat (Hirzel *et al*., 2011 and (Artacho et al., 2009). In Tanzania, rice is the second most important food and commercial crop after maize; it is among the major sources of employment, income and food security. About 71 % of the rice grown in Tanzania is produced under rain fed conditions while 29 % of the total production is under irrigated conditions. Most of the rice varieties grown in Tanzania are traditional such as Shingo yamwali, Tule na bwana, Mbawambili, Kaniki and Kilombero (Artacho et al., 2009). These varieties have long maturity and their yields are lower (2.5 - 4t ha^{-1}) than the yield of improved varieties such as SARO 5 (10 t ha^{-1}) (Ceesay, 2004). The increase in production is hindered by many factors such as high input costs and low price of the product. There is thus an urgent need for cultivars and production technologies and systems such as a System of Rice Intensification (SRI) in both the upland and lowland ecosystems that increase yields at low monetary costs and saving water (Ceesay, 2004). The SRI is a standard package of specific practices that significantly reflect local conditions based on the bio-physical mechanisms within agro-ecological environments (Katambara *et al*., 2013). Its practice consists of principles ranging from seed sorting, sowing, and transplanting

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younger seedlings, weeding, and water management. The SRI practice has been reported to result in higher yields ranging from 6 to 8 ton/ha with subsequent water saving of up to 25% (Katambara *et al*., 2013).

In Tanzania, the demand for irrigation water outstrips the amount of water available for irrigation and other demands, and the demand for more food to feed the growing population is increasing, calling for the need to have technologies and farming practices that ensure more food production while minimizing water uses. The majority of rice producers in Tanzania and Sub-Saharan Africa (SSA) are subsistence farmers practicing continuous flooding that requires much water and conventional practices of growing paddy using local varieties and transplantation using too old seedlings of more than 25 days old as well as transplanting 3 - 4 seedlings in one-hole results in low yields, low water productivity and low water use efficiency (Katambara *et al*., 2013). At Mvumi Irrigation Scheme in Kilosa District in Tanzania the site of the current study, farmers employ conventional practices of growing paddy transplanting using too old seedlings resulting in low yields. Therefore, the reported study focused on the following: To test and deploy site specific SRI practices (age of seedlings at transplanting, spacing.) that use resources (water, seed, and fertilizer) efficiently, reduce costs but increase productivity under conditions of changing climate.

2. Materials and Methods

A. Experimental Site

The study involved a field experiment which was conducted at Mvumi Irrigation Scheme - Mvumi village in Kilosa District in Morogoro region –Tanzania. Mvumi is one of the villages in Kilosa district, the village is located from Longitude 37o10'E (eastward) and from Latitude 6o34'S (southward). Kilosa District covers 14,918 square kilometers. It is bordered to the north by the Manyara Region, to the northeast by the Tanga Region, to the east by Mvomero District, to the southeast by Morogoro Rural District, to the south by Kilombero District, to the southwest by the Iringa Region and to the west by the Dodoma Region. According to the 2002 Tanzania National Census, the population of the Kilosa District was 489,513 (URT, 2002).

B. Characterization of the Study Soil

Soil samples were taken from a depth of 0-20 cm. Four sub samples were collected using a hand hoe from four different points in an area of one acre farm and were put in a plastic sheet. The soil sample was mixed and divided diagonally several times to obtain a minimum composite sample of 1kg. The sample was sent to SUA soil laboratory for physical and chemical analysis. The physical and chemical properties of the soil were determined at SUA Soil Science Department laboratories. Parameters analyzed included pH in water (1:2.5), available P according to Bray and Kurtz (1945), total N according to Kjeldahl, 1883, organic carbon according to Walkley and Black (1934), exchangeable bases (Ca^{2+}, Mg^{2+}, Na^+ and K^+) extractable Zn and extractable Fe according to Lindsay and Norwell (1978), exchangeable Al and sulfur.

C. Seed and Nursery Preparation

Rice seed cultivar SARO 5 was bought from the Tanzania Farmers Association shop which is adjacent to Msamvu Bus Terminal in Morogoro. The seed were prepared by separating unfilled from filled grains in order to obtain well filled (heavy) grains that ensured high germination percentage resulting into seedlings with high growth vigor. The seed were winnowed and put in clean water in a dish, followed by thorough stirring and the removal of all floating seeds. Salt was added gradually in small quantities into a bucket containing 10 liters of water followed by a thorough mixing (plate 1). A fresh hen's egg was immersed in the formed brine solution and the right concentration of the salt was determined by a floating egg (plate 2). The seeds which remained after removing the floating ones from fresh water were transferred into the salt solution to ensure a complete separation of unfilled seeds from filled seeds. Thorough stirring of the solution resulted in viable seeds sinking to the bottom and non-viable seeds floating on the surface, and were easily removed. The seeds that sank were washed using clean fresh water five times in order to remove the salt. Two 1 m x 10 m wet and well leveled nursery beds were prepared. Subsequently the seeds were soaked in a large container of water for 24 hours followed by incubation which was done by putting the seeds in a netted bag for 36 hours in order to initiate their germination

D. Seed Soaking, Incubation and Sowing into the Nursery

After suitable seeds had been obtained from the floatation process, they were soaked by putting them in a 10 L bucket of water for 24 hours. Following the removal from water the seed was incubated in a netted bag for 36 hours in order to initiate their germination (emergence of the embryo). The pre-germinated seeds of SARO 5 variety were then sown into the nursery beds. Three (3) kg of the seeds were evenly distributed on the nursery beds with 1.5 kg to each nursery bed, and other management practices such as water management, fertilizer application, weed control and irrigation followed as per SRI. After the seedlings reached the age of 10, 12 and 14 days after emergency (DAE) in the nursery, they were transplanted into the main field.

E. Determination of the Optimum Age of Rice Seedlings and Optimal Spacing at Transplanting

Rice seedlings at age of 10, 12 and 14 days after emergence (DAE) were uprooted from a nursery and transplanted in the main field. Spacing of 20 cm x 20 cm, 25 cm x 25 cm and 30 cm x 30 cm were adopted where each treatment was replicated three times. To study the effect of spacing on the performance of rice, the three main plots were divided into nine subplots where the seedlings were transplanted in each subplot spaced at 20 cm x 20 cm, 25 cm x 25 cm and 30 cm x 30 cm with each treatment being replicated three times. Control plots were planted with randomly spaced seedlings of 21 DAE as practiced by most farmers in conventional rice production in the Mvumi Irrigation Scheme (Table 1). Each of the treatments was replicated three times.

Table 1
Treatment combinations and crop management practices

Crop management practices	Age of transplanting	Treatment (spacing)	Water management
System of rice intensification (SRI)	10 DAE	20 X 20	Alternate wetting and drying (AWD)
		25 X 25	followed by wetting after 5 to 7 days
		30 X 30	
	12 DAE	20 X 20	
		25 X 25	
		30 X 30	
	14 DAE	20 X 20	
		25 X 25	
		30 X 30	
Non-SRI/Conventional practice	21 DAE	Randomly	Continuous flooding (non-SRI)

F. Water Control and Fertilizer Application

Water was controlled by alternating dry and wet periods. The water was allowed into the field and allowed to stay and used by the crop until the soil started to show cracks because of drying up. The time taken from water entrance in the field to the signs of soil cracks was approximately 5-7 days. A shallow water layer of 1cm from the surface of the soil was introduced into the paddy field during the vegetative period. The plots were left to dry until cracks become visible, when another thin layer of water was introduced (Alternative Wetting and Drying (AWD). Two weeks after transplanting the main water control gate broke down, it thus from this stage became impossible to impose -the Alternative Wetting and Drying (AWD) regime. All plots became flooded a situation that continued to harvesting time. Phosphate and nitrogen fertilizers were applied separately for optimum rice growth. Forty kilograms of phosphate (P2O5) fertilizer was basally applied to facilitate early plant establishment before field crop establishment while nitrogen fertilizer was applied as split application (top dressing). Eighty kilograms (80kg N/ ha) of UREA fertilizer was applied in two equal splits, 40 kg were applied at 14th DAT and 40 kg/ha were applied at 35th DAT. The second split N application is aimed at promoting high tillering, increasing number of spikelets, influencing grain filling (large grain size) and hence high quality and high grain yield(Angus et al., 1994; Wilson et al., 1994a; Sahrawat, 2006; Bouman et al., 2007; De-Xi et al., 2007; Jing et al., 2008).The application of fertilizer was supposed to bed one when the field water level was 3 cm so as to enhance crop response to applied N rate to allow the increase of N use efficiency (Beşer, 2001; Jing, 2007; Bushong et al., 2007; Ortega, 2007). But due to the continuously flooding of the field, N was applied while the field had more than 3 cm water level.

G. Vegetative Growth and Grain Yield Parameters Data

After the plants attained 60 DAT, 10 rice plants were uprooted from each experimental plot, with 5 rice plants from each diagonal of each experimental plot and then placed in envelopes labeled with the replicate number, age of rice seedlings at transplanting and the spacing of the seedlings used at transplanting. The data collected from the uprooted rice plants included the number of tillers per hill, the number of productive and non-productive tillers. Numbers of tillers were obtained by counting the total number of tillers of each rice plant. The results of ten rice plants from the same experimental plot were summed up and used in calculating the mean of the number of tillers per hill. The same procedures were followed in obtaining the number of productive and non-productive tillers. Other parameters that were recorded are plant height, flesh weight dry weight, total grain yield, thousand seed weight, weight of shelled rice, shelling percentage and moisture content of shelled paddy.

H. Statistical Data Analysis

The data were organized using MS-Excel computer program. Statistical analysis of the data was in accordance to Split plot in CRBD by employing GenStat Computer Software. The analysis of variance (ANOVA) technique was employed based on the Least Significance Difference (LSD) to separate significance among the treatments means at 5% level of significance as proposed by Wim et al., (2007).

3. Results and Discussion

A. Physical and Chemical Properties of the Soil from the Study Site

Results of physical and chemical properties of the soil from the study area are as presented in Table 2.

Table 2
Some physical and chemical properties of the study soil

Parameter	Unit	Value	Category
pH		6.98	Neutral
Total N	%	0.46	Medium
Organic carbon	%	2.78	Low
Organic matter	%	4.79	High
SO_4– S	mg kg^{-1}	17.51	High
C/N ratio		6.04	High
Available P	mg kg^{-1}	5.60	Very Low
Exchangeable Ca	$Cmol_{(+)}$ kg^{-1}	29.45	Very High
Exchangeable Mg	$Cmol_{(+)}$ kg^{-1}	10.47	Very High
Exchangeable K	$Cmol_{(+)}$ kg^{-1}	0.42	Medium
Exchangeable Na	$Cmol_{(+)}$ kg^{-1}	0.16	Low
Clay	%	48	
Silt	%	5	
Sand	%	47	
Textural class		Sand Clay	
Extractable Cu	mg kg^{-1}	0.92	High
Extractable Zn	mg kg^{-1}	2.55	High
Extractable Mn	mg kg^{-1}	34.10	High
Extractable Fe	mg kg^{-1}	47.42	High
Exchangeable Al	%	0.02	Very Low

B. Texture, pH, Total N, Bray -1-P, OC, Exchangeable Al, Zn, Fe, and K of the Study Soil

1) Soil Texture

The soil at the study site was a sand clay whose particle fractions were in the order clay > sand > silt (Table 1). Clay soil particles enhance retention and ease release of large amount of the essential nutrient elements and water in the soil for plant uptake and the water retention increases as the organic matter increases in the soil Rawls *et al*. (2003). These results suggest that the soil is relatively fine textured making it turbid when wet; and probably the spore space system is small, but numerous and high in water retention capacity. High amount of obtained for this soil could be attributed to the fact that rice straw is left on the field after harvest. The study soil was sampled at a depth of 0 -20 cm, a surface soil which is prone to accumulation of organic residues and humus. The soil was good at retaining soil moisture and was relatively easy to plough.

2) Soil pH and Macro nutrients (NPK)

The pH level (6.98) of this soil potentially reflects that most nutrients are available in the soil. Among the nutrients analyzed, the macronutrients such as nitrogen, potassium, calcium, magnesium and Sulphur are easily available in the soil for their susceptibility for plant uptake. However, the availability of these plant nutrients for easy plant uptake is plant specific and depends on the form of the nutrient element and its balance with other ions as well as soil moisture at the time of active nutrients requirements by the plant. The level of total nitrogen in the study soil was medium (0.46 %), The medium level of nitrogen in the study soil mighty have been caused by leaching, and denitrification due to poor soil aeration because the field was almost flooded in most of the cropping season. Nitrogen was applied during the experiment which probably raised the level of N to high level. The level of P in the study soil was very low (5.6 $Cmol_{(+)}$ kg^{-1}) The very low P value might be caused by the Ph. level (6.98) which caused fixation of P by, iron, and calcium which are high in the soil (Table 1). Upon the application of DAP probably the P level raised up although no soil test was done after the experiment to exactly know the amount of P raised up. The level of potassium was medium, (0.42 $Cmol_{(+)}$ kg^{-1}), the medium level might be caused by leaching of potassium beyond the root zone Potassium was not applied during the experimental time, therefore upon further uses of the farm potassium have to be applied.

3) Micro Nutrients

The high Zn content is usually favored by low soil phosphorus, low pH, warm temperature, dry soil and high organic matter (Gerenfes and Negasa, 2021; Capo et al., 2024). Based on the laboratory data obtained, it was more likely that the high level of Zn (2.55 mg kg-1) was contributed by the relatively high amount of organic matter and very low P levels in the soil. Therefore, the above argument does not call for an application of Zn, Cu, Mn and Fe containing fertilizers because their amount in the soil system is high. The nature of the soil (Sand clay) indicates that the soil had possible high levels of the retention and release of cationic nutrient elements such as K+, Ca2+, Mg2+, and NH4+. The same could also be true for nutrients such as Mn2+, Cu2+, Fe2+ and Zn2+among others. Maintenance of adequate levels of micronutrients in the soil calls for regular incorporation of easily decomposable organic residues and composts.

4) Organic Matter (OM)

The high organic matter content (4.79%) in the soil expresses the poor quality of C: N ratio (Miller, 2000). The poor quality recorded indicates low rate of mineralization of organic materials which is accompanied by low rates of decomposing materials due to flooding. At Mvumi Irrigation Scheme crop residues are left in the field regularly. Cover crops can also be used for improving the structure of the soil in the large target of increasing the nutrient pool of the field. The soil organic matter is important to a wide variety of soil chemical, physical and biological properties. As soil organic matter increases, soil total N content, and other soil properties such as water holding capacity and microbiological activity also increases.

C. Effect of Age and spacing of Seedlings at Transplanting on Tillering, and Plant Height

1) Effect of age and spacing of seedlings at transplanting on tillering

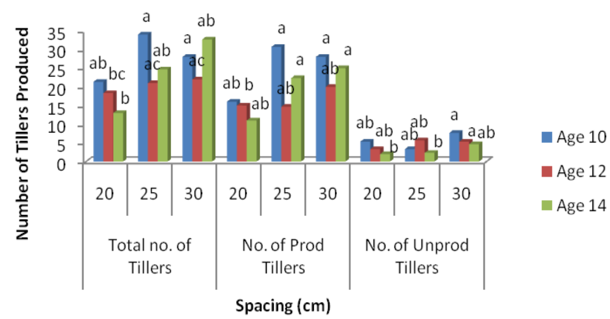

Fig. 1. Categories of tillers as affected by transplanting Age and Spacing of seedlings

Results of tillering as affected by spacing and ages of rice seedlings at transplanting are as presented in Fig. 1. The results show that, rice seedlings transplanted 10 DAE and spaced at 25 cm x 25 cm produced the largest number of total tillers on the average than other rice seedling ages. The lowest number of total tillers were recorded from the seedlings of 14 DAE spaced at 20 cm x 20 cm. The large number of tillers of 10DAE with 25cm x 25 cm seedlings were probably due to preserved potential for tillering and root growth as well as the enough space the plants had which reduced competition for nutrients, water and sunlight among the plants, while the low number of tillers for the seedlings of 14 DAE spaced at 20 cm x 20 cm were probably caused by the low tillering potential of the seedlings in the field caused by staying many days (14) in the nursery, as well as the little space between plants which resulted into competition for nutrients, sunlight and water (Balasubramanian *et al*., 2005) Fig. 1. The number of productive tillers also varied, but not significantly different. The seedlings of 10 DAE spaced at 25 cm x 25 cm had the highest number of productive tillers and the seedlings of 14 DAE spaced at 20 cm x 20 cm showed a lowest number of productive tillers as shown in Fig 1 (a). In unproductive tillers, the seedlings of 10 DAE spaced at 30 cm x 30 cm showed the highest number of unproductive tillers while the lowest number of unproductive tillers was shown by seedlings of 14 DAE spaced at 20 cm x 20 cm in the field. Transplanting very young seedlings usually 8-10 days old not more than 15 days old had better tillering and rooting with increasing effects in grain yield if the transplanting was done after the 4th phyllochron usually about 15 days after emergence (Uphoff, 2002). Anitha and Chellappan (2011) found that planting of single seedling per hill in straight rows both ways, alternate wetting and drying, early and frequent weeding using mechanical weeders encouraged the proliferation of microorganisms that symbiotically enhanced the plant capability to produce more tillers, with vigorous and healthy root growth, and a larger number of panicles heavily laden with grains. With a more vigorous root growth, plant got better access to the nutrients and water they required to produce tillers and grains.

2) Effect of age and spacing of seedlings at transplanting on plant height

The results show that, the gain in plant height after transplanting was decreasing with increasing ages of the transplanted seedlings. The younger the transplanted seedlings the higher the ultimate plant height Fig. 2. The 12-day aged seedlings spaced at 20 cm x 20 cm had high plant height while the seedlings of14 DAE spaced at 30 cm x 30 cm had the lowest plant height. Many literatures show that the seedlings of 8-10 DAE spaced at 25 cm x 25 cm results into high plant height which is caused by the short time a seedling stays in the nursery before reaching its maximum tillering stage, but the experimental results are vice versa, which might be caused by the effect of age (12 DAE) of seedlings to overlook the effect of spacing (20 cm x 20 cm) and resulted into highest plant height, and the effect of age (14 DAE) of seedlings to overlook the effect of spacing (30 cm x 30 cm) and resulted into lowest plant height. Maximum tillering stage is a stage when tiller number per plant or per square meter is maximum before or after the initiation of panicle primordial, depending on a variety's growth duration. Because tiller number declines after the maximum tiller number stage, there is a period before that stage (often called the end stage of effective tillering) when the tiller number becomes numerically equal to panicle number at maturity. That does not necessarily mean that tillers developed after the end stage will not bear panicles (https://www.unihohenheim.de/fileadmin/einrichtungen/risocas/downloads/mb_00155.pdf) December 2015.But tillers developed at early growth stages normally produce panicles, while those developed later may or may not. Similar findings were made by Gokila (2005) and Sivakumar (2006) that the plant height decreases with increasing ages of the transplanted rice seedlings.

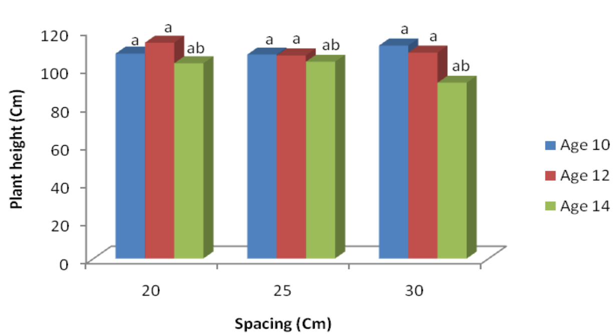

Fig. 2. Plant height as was affected by transplanting Age and Spacing of seedlings

3) Effect of age and spacing of seedlings at transplanting on total grain yield

The results show that the seedlings of 10 DAE spaced at 25 cm x 25 cm resulted into the highest grain yield while the seedlings of 14 DAE spaced at 20 cm x 20 cm resulted into lowest grain yield (Fig. 3). The highest grain yield might be attributed to the wide spacing between plants which provided enough space for root growth and the younger the seedlings which had high growth and tillering potential.

The decrease in grain weight was caused by the increase in the ages of the seedlings at transplanting which also caused by reduced potential of tillering capacity of the seedlings. Similar findings have been reported by Migo and Datta (1982) that the very young seedling (10 days old) produced higher grain yield and yield attributing characters such as productive tillers than the old seedlings (21 and 45 days old) which yielded 2.4t ha^{-1}.The yield is low compared to SRI literatures, the low yield was caused by frequent water availability which infiltrated into the experimental plots from the surrounding farms which were practicing conventional cultivation, this led to reduced number of tillers and finally low yield.

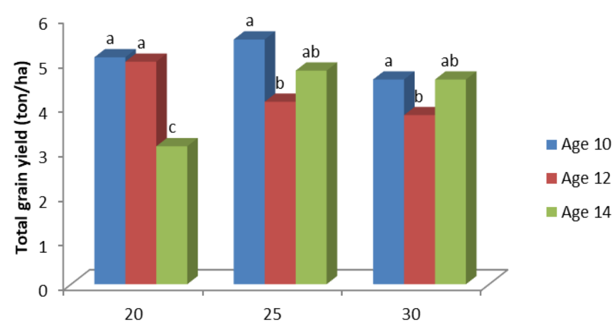

Fig. 3. Total grain yield as was affected by transplanting Age and Spacing of seedlings

4) Effect of age and spacing of seedlings at transplanting on shelled paddy

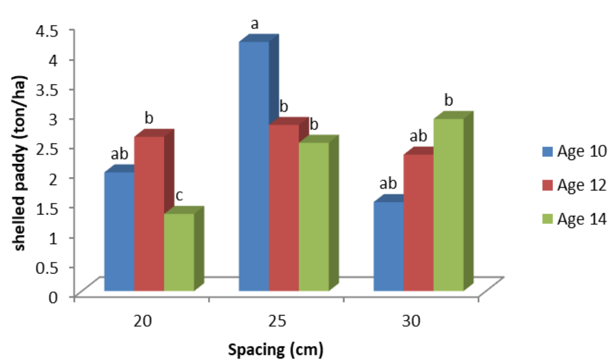

Fig. 4. Shelled paddy as was affected by transplanting age and spacing of seedlings

Generally, the quantity of shelled paddy was high for the seedlings of all ages spaced at 25 cm x 25 cm, followed by the seedlings spaced at 30 cm x 30 cm and finally by the seedlings spaced at 20 cm x 20 cm. The seedlings of 10 DAE spaced at 25 cm x 25 cm gave a highest quantity of shelled paddy, while the lowest quantity was from the seedlings of 14 DAE spaced at 20 cm x 20 cm (Fig. 4). The highest quantity given might be attributed to the large number of productive tillers produced by the seedlings of 10 DAE spaced at 25 cm x 25 cm.

5) Shelling percentage as was affected by transplanting age and spacing of seedlings

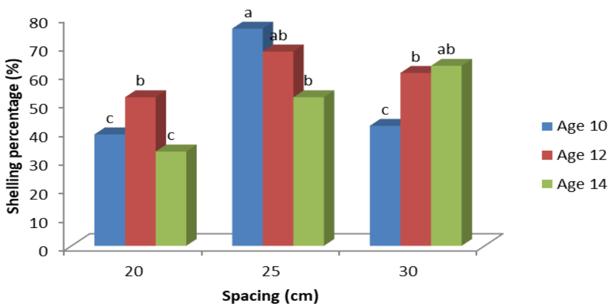

Fig. 5. Shelling percentages as was affected by transplanting Age and Spacing of seedlings

6) The weight of 1000 grains as were affected by transplanting Age and Spacing of seedlings

The weight of 1000 grains did not show much deviation, (Fig. 6), the rice rains sampled from all ages spaced at each spacing resulted into almost the same weight. But many literatures say the younger seedlings result into grains of high weight compared to older seedlings. Datt and Gautam (1988) found that 1000 grain weight were significantly higher with young seedlings. According to Thanunathan and Sivasubramanian (2002), age of seedling had significant influence on grain weight.

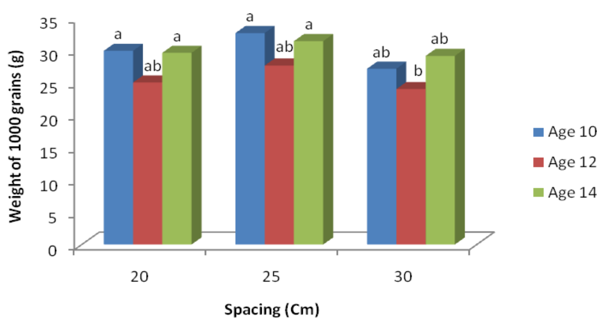

Fig. 6. Weight of 1000 grains as was affected by transplanting Age and Spacing of seedlings

7) Effect of age and spacing of seedlings at transplanting on Biomass Production (Flesh and Dry matter weight)

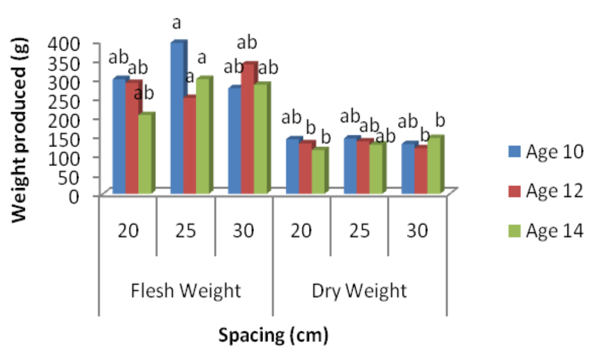

Fig. 7. Flesh and dry matter weight as was affected by transplanting Age and Spacing of seedlings

Results (Figure 7) the highest (395 g) flesh matter yield was noted in the 10 aged seedlings with 25 cm x 25 cm (Fig. 7), which dropped by 24% to 300 g of 10 aged seedlings which then dropped to 276 g by 30 %. Mandel *et al.* (1984) stated that higher flesh matter was recorded by transplanting young seedlings (25 days old) followed by 35, 45, 55 and 75 days old seedlings of early maturing variety (Jeyaraj and Anbumani, 2005). The 14 days old seedling planted at 25 x 25 cm recorded higher grain yield of 7009 and 5655 kg ha-, respectively, during wet and dry seasons (Vijayakumar *et al*., 2005).

8) Effect of age of seedlings at transplanting on dry matter production

Results show that the highest dry matter yield was noted in the 10 aged seedlings which had 139.3 g, which dropped by 7% to 129.3g of 12 aged seedlings which then dropped to 125.7 by 10 % (Fig: (3). JIANG et al. (2023) stated that higher dry matter was recorded by transplanting young seedlings (25 days old) followed by 35, 45, 55 and 75-days old seedlings of early maturing variety (Jeyaraj and Anbumani, 2005). The 14 days old seedling planted at 25 x 25 cm recorded higher grain yield of 7009 and 5655 kg ha-1, respectively, during wet and dry seasons (Vijayakumar et al., 2005).

9) Comparison of SRI and non-SRI means

Non-SRI plot (farmers plot) did not yield high compared to the SRI plots (Appendix 1). The low yield of the non-SRI plot was attributed to the conventional practices which included zigzag transplanting of the rice seedlings, flooding of the field. Flooding of the field throughout the season reduced the growth of weeds but at the same time reduced the number of tillers per hill as a result led into low yield (Stoop et al., 2002; Thakur et al., 2010; Kaspary et al., 2020)). Allowing water throughout the season reduced soil aeration that affected the growth of plant roots and tillering ability of the plants in the field, and hence led to small panicles to be formed with half-filled grains.

4. Conclusion

Based on the findings of this study it is recommended that, need for application of organic residues and nitrogenous fertilizers. Based on these results of the lab work the appropriate recommended rates for N is 60- 80 kg N = UREA (174 kg or 3.5 bags) ha^{-1}. The recommended rate of P is 60 kg P_2O_5 (333 kg or 6.5 bags) for SSP source or 60 kg P_2O_5 (132 kg 0r 6.7 bags) for TSP source of P nutrient. The recommended rate for K is 30 kg K_2O (50 kg or 1 bag MOP). Generally, a combination of young seedling of the age of 10 days spaced at 25 cm x 25 cm shows good results in terms of total number of tillers, number of productive tillers, total grain yield, quantity of shelled paddy, shelling percentage as well as flesh and dry matter production. In spite of transplanting seedlings of 10 DAE and spacing them at 25 cm x 25 cm, a farmer should transplant a single seedling per hill, weed mechanically and alternating wet and drying period in order to get high yield.

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