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IMPROVING IRRIGATION WATER USE EFFICIENCY FOR POTATO CROP PRODUCTION UNDER SANDY SOIL CONDITIONS

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ABSTRACT

The aim of irrigation management during the potato growing season should be to maintain the soil water content in the 0-60 cm depth between the "Full point" and the "Refill point" to minimize excess soil water content, which could leach below the root zone, and avoid soil water stress effects on the crop. Greenhouse experiments with pieces of rice straw were carried out during the growing season 2006/2007 (October to January) in an Arid Land Research Center, Tottori University, Japan. The present study included four irrigation intervals (every day, every two days, every three days and every four days) and five different mixed ratio between rice straw pieces and sandy soil (0, 10, 20, 30 and 40 % by volume). The objective of the present research was increase sandy soil holding capacity and improves irrigation water use efficiency for potato crop production.

The important results that obtained from the present work were as follows:-

- The maximum value of water consumptive use was 580 mm/season that obtained with 0.3 and 0.4 straw-soil ratio for four days irrigation interval.
- Irrigation drainage water increased by about of 62.30, 197.39 and 283.37% for 2, 3 and 4 days irrigation intervals, respectively comparing with every day irrigation interval.
- Irrigation every day gave the highest values of water application efficiency because increase irrigation intervals tended to increase deep percolations (water drainage).
- The average values of tuber yield were 7.93, 9.56, 8.36 and 6.30 Mg/fed. for irrigation intervals 1, 2, 3 and 4 days, respectively.
- The results indicated that, increasing rice straw-soil ratio tended to increase irrigation water use efficiency due to decrease irrigation water drainage by increasing rice straw- sandy soil ratio.

INTRODUCTION

Yield and quality of a potato crop are controlled by the most limiting factor or interaction(s) of limiting factors. Moisture deficit or excess is one of the major yield and quality limiting factors in potato production. However, planting crops in arid areas requires special technologies to make the optimum use of scarce water. Potato can be sensitive to irrigation less than ETc. Shock *et al.* (1998) proposed a 3-year study on silt loam in eastern Oregon to examine the effect of water deficit on yield and quality of four potato cultivars. Application rates less than ETc in the Treasure Valley of Oregon affected crop yield and can not be adopted as a feasible irrigation scheduling strategy to economize water. This is because the small benefit eventually obtained by the grower with irrigation water amounts less than ETc would not counterbalance the high risk of reduced tuber yield and profit from water saving. Clinton *et al* (1999) found that potato (Solanum tuberosum) responds negatively to soil moisture deficits so that precise irrigation scheduling is essential. economic losses due to decreases in tuber yield, grade and internal quality place a premium on careful irrigation management. Potato evapotranspiration varies with production site. An important indicator of soil physical fertility is the capacity of soil to store and supply water and air for plant growth. The ability of soil to retain water is termed water holding capacity (WHC). In particular, the amount of plant-available water in relation to air-filled porosity at field capacity is often used to assess soil physical fertility (Peverill *et al*, 1999). Best Management Practices (BMP) involves the proper management of irrigation applications to meet the water requirements of the crop without wasting water, soil, or nutrient resources. Irrigation water should be managed so that the water table depth is maintained 38 to 61 centimeters from the top of the potato row (Hutchinson *et al.*, 2002). Potato (*Solamum tuberosum L.*) are one of the most important crops in the world. They are also very sensitive to moisture stress because their root system is relatively sparse; approximately 85% of the root length is concentrated in the upper 30 cm of the soil layer. This sensitivity to moisture stress can lead to dramatic fluctuations in yield due to frequent drought and poor irrigation management (Kang *et al.* 2002). King, *et al* (2003) studied potato production with limited water supplies. They found that water stress during the vegetative growth stage reduces leaf area, vine and root expansion, plant height, and delays canopy development. Water deficits during vegetative growth have also been shown to decrease the number of tubers set per plant, which then results in fewer and larger tubers at harvest. Kashyap and Panda (2003) found that the maximum and average daily ET of potatoes was 4.24 and 2.49 mm, respectively. Under hot dry conditions in northeastern Portugal, peak ET rates reached 12–13 mm per day on days immediately following irrigation, but then declined logarithmically to about 3 mm per day within 5 days under sprinkler irrigation. Wolf and Snyder (2003) stated that an increase of 1% soil organic matter (SOM) can add 1.5% additional moisture by volume at field capacity (FC). Onder et al., (2005) mentioned that water is the most important limiting factor for potato production and it is possible to increase production levels by well-scheduled irrigation programs throughout the growing season. Pereira and Shock (2006) reported that potato crop is a shallow rooted, water stress sensitive crop. Water deficits reduce tuber yields and quality. Tuber quality parameters that are influenced by water stress include tuber grade, specific gravity, heat necrosis, susceptibility to bruise, hollow heart, translucent-end, jelly end rot, and the dark color of fried strips and chips. Tolga *et al.* (2006) determined the effect of different irrigation methods and irrigation regimens on potato yield in the Trakya Region. Potato was grown under furrow and drip irrigation methods and three regimens (30, 50, or 70% of the available water). They found that, the seasonal potato evapotranspiration ranged on 464 to 683 mm. Water use efficiency values increased from 4.70 to 6.63 kg m^{-3} for furrow-irrigated treatments, and from 5.19 to 9.47 kg m^{-3} for drip-irrigated treatments. Stark *et al.* (2006) mentioned that irrigation is required for profitable commercial potato production in the western U.S. Potatoes have a relatively shallow root zone and a lower tolerance for water stress than most other crops grown in Idaho. The preference for producing this drought sensitive crop in coarse-textured soils with limited water holding capacity makes precise irrigation management a necessity to obtain optimum yield and quality. When restricted water availability reduces potato production potential, options for increasing water use efficiency need to be considered. Tolga *et al* (2006) determined the effect of different irrigation methods and irrigation regimens on potato yield. Their results found that seasonal potato evapotranspiration ranged on 501 to 683 mm in 2003, and 464 to 647 mm in 2005. Water use efficiency values increased from 4.70 to 6.63 kg m^{-3} for furrow-irrigated treatments, and from 5.19 to 9.47 kg m^{-3} for drip-irrigated treatments. Patel, N. and T. B. S. Rajput (2007) mentioned that drip irrigation has been shown to be a more water efficient alternative to traditional sprinkler and furrow irrigation systems for potato (*Solanum tuberosum L.*) Heikal *et al.* (2008) evaluated the effects of irrigation systems and compost application amount on potato yield. Their results indicated that under the fertilizer doses (without N) and soil experiment conditions, the maximum values of potato tubers were 10.88 and 6.8 t/fed. obtained by 30 m^3/fed. composed; under subsurface drip irrigation and gated-pipe long furrows, respectively. Nagaz *et al.* (2008) evaluated the effects of drip and furrow irrigation methods on soil salinity, yield and water use efficiency of Potato (Solamum tuberosum L.). Field experiment was conducted on a sandy soil in arid conditions of Tunisia. Their results indicated that, under drip irrigation, 20.8% of the irrigation water was saved in comparison with furrow irrigated potato, and irrigation water use efficiency increased by 29% compared with that of furrow irrigation. Drip irrigation method provides significant advantage on yield and WUE, compared to furrow irrigation in potato production under experimental conditions.

The aim of the present work is to develop new moisture holding material (MHM) from waste biomass (rice straw) which can be used in sandy soil and determine the effects of deferent irrigation intervals on potato production.

MATERIALS AND METHODS

Chopping rice straw into short pieces (0.5 to 3 cm) makes incorporation easier, reduces tillage operations and improves straw/soil contact. These advantages appear more pronounced in non-flooded conditions. Pieces of rice straw was added as a soil moisture holding material which farmers could produce by themselves and use without carbonating process.

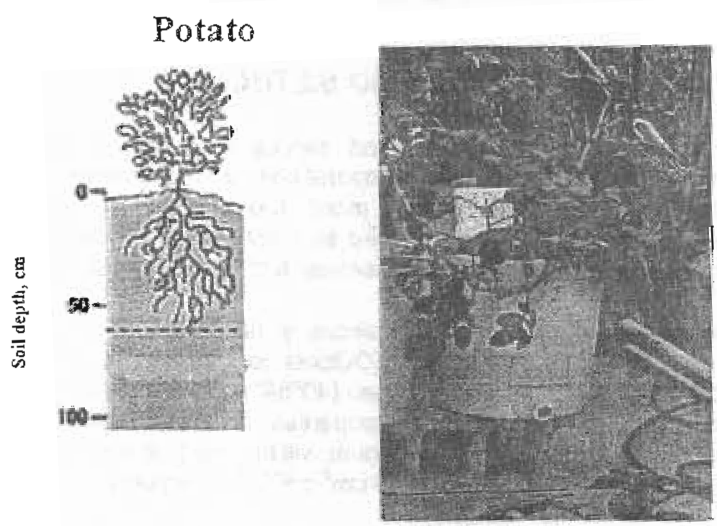
Greenhouse experiments with pieces of rice straw were carried out during the growing season 2006/2007 (October to January) in an Arid Land Research Center, Tottori University, Japan (40°59' N, 27°29' E; altitude, 4 m). Table 1. indicates the soil physical properties of the experimental field. Average field capacity (FC) and permanent wilting point of the sandy soil in experimental area were 0.113 and 0.044 cm^3 cm^{-3}, respectively.

Table 1 : Soil physical properties for experimental soil

Depth (cm)	Textural fractions (%)				Texture class	Soil bulk density (g cm^{-3})	P.W.P. cm^3 cm^{-3}	F.C. cm^3 cm^{-3}
	Sand	Silt	Clay	O. M.				
0 – 20	94.10	1.70	3.80	0.40	Sandy	1.56	0.022	0.074
20 – 40	93.50	0.80	5.00	0.70	Sandy	1.51	0.065	0.153
40 - 60	92.60	1.40	5.40	0.60	Sandy	1.49	0.044	0.113

The soil is very sandy and highly erodible; it literally melts and flow when exposed to water. It has very little organic content, nutrient or water holding capacity. The present research attempted to correct some of the soil deficiencies by adding pieces of rice straw to the sandy soil to increase the organic content, water holding capacity and cation exchange capacity. The pieces of rice straw were mixed with sandy soil by different rates. Pre-sprouted potato tubers (*Solanum tuberosum L. cv. Satina*) were planted manually, at a depth of 5-7 cm on October, 4, 2006 and harvested on January, 26, 2007. Fertilizer applications were based on soil test data a composed fertilizer including 150 kg ha^{-1} N and 60 kg ha^{-1} P_2O_5 was utilized. The experiment was arranged in a split-plot design, with four irrigation intervals as main plots and five maxing rates of rice straw and sandy soil as subplots with three replicates. The cultivation tests were performed in a glassed greenhouse under the natural light. Plastic pots with a capacity about of 200 liters were used for cultivation tests as shown in Figs. 1 and 2. The drip irrigation system consisted of main line from PVC 5 cm diameter; sub main line 2.5 cm diameter and lateral line made from PE 16 mm diameter. Built-in emitters (GR) were used with outlets spacing of 100 cm and 2 l h^{-1} flow rate.

Fig. 1: Potato plants as in an experiments sites



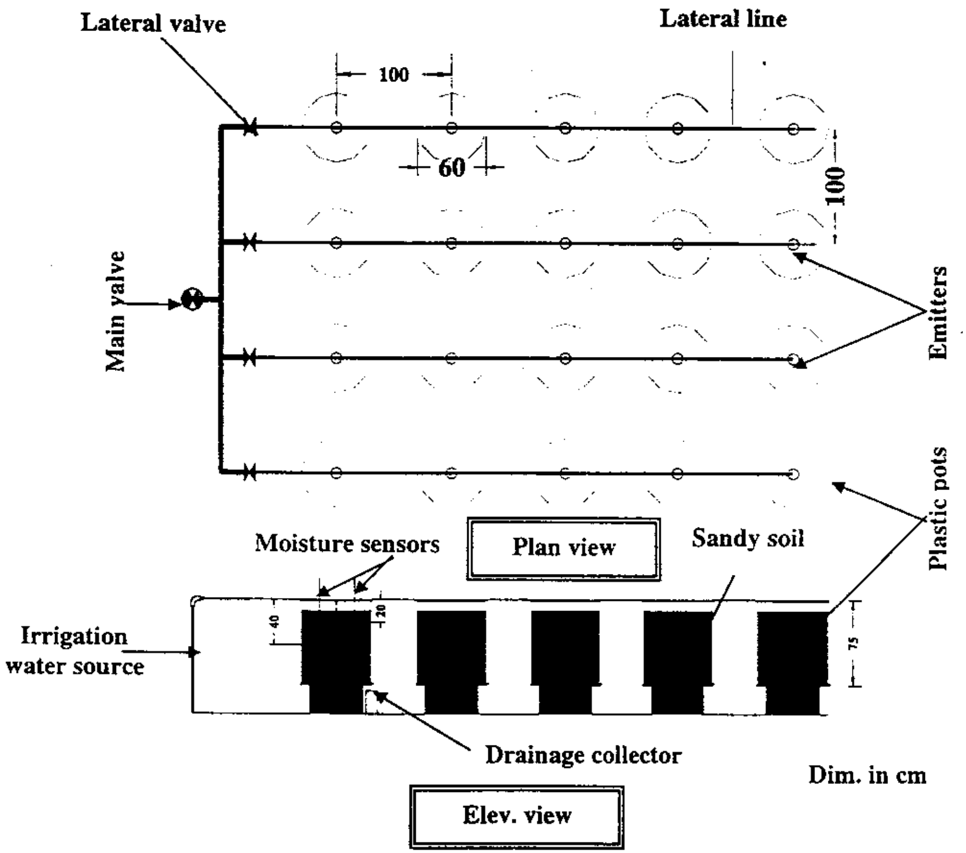


Fig. 2: Experiments layout

Treatments:-

The present studied included the following treatments:-

(i) Irrigation intervals: four irrigation intervals were used every 1, 2, 3 and 4 days. The irrigation time was estimated based on amount of the applied water (AIW_m) and emitter discharge.

(ii) Mixing rates between pieces of rice straw and sandy soil:
Five different rates were used 0, 10, 20, 30 and 40 % by volume.

Crop water requirements,(ET_c):

It was calculated from the following equation (*Ismail, 2002* in Arabic) :-

$$ET_c = K_c * K_r * ET_o \quad \text{......} \quad (1)$$

Where :-

ET_c = Crop water requirements, mm/day

K_c = crop factor (1.0, 1.15 and 0.75 for the initial stage; mid-season stage and late stage, respectively according to (*Ismail, 2002*).

K_r = reduction factor (it is depending on distance between laterals, emitter discharge and soil texture (*Sakla, 1991*). Its value equal one in the present study).

ET_o=reference evapotranspiration, mm/day, which was calculated depending on climatic data. The climatic data was collected from 1st of April to 30th of August and the average values of maximum temperature, minimum temperature, wind speed and relative humidity were 36.8 °C, 14.2 °C, 2.9 m s^{-1} and 75%, respectively.

Applied irrigation water,(AIW):

For each irrigation time, the amount of the applied irrigation water was calculated according to the following equation:

$$AIW_m = \frac{\sum_{i=1}^{i=n} ET_c}{E_a(1-LR)} \qquad (2)$$

Where:-

m = irrigation number;

n = soil layer number;

Ea = designed water application efficiency, which was 0.85 in the present study according to (*Ismail, 2002*), and

LR = leaching requirement, which was 10% from ET_c in the present study.

Seasonal applied irrigation water was calculated from the sum of AIW_m

Leaf Area Index, (LAI):

Leaf area index is the ratio of total upper leaf surface of vegetation divided by the surface area of the land on which the vegetation grows. Leaf area index is determined directly by taking a statistically significant sample of foliage from a plant canopy, measuring the leaf area per sample plot and dividing it by the plot land surface area. Traditional leaf area index meters require each plant leaf to be stripped and fed through the entrance of the machine, which can be likened to a kind of crude image scanner.

Water consumptive use, (WCU):

Crop water consumptive use is the amount of water transpired by the plants plus the water evaporated from the soil plus the fraction of water held by the plant tissues. The amount of water retained by the plant metabolic activity is about 1% of the overall water taken up by the plants. Thus, in practical terms crop water consumption corresponds to crop maximum evapotranspiration (ET_c), which included the evaporation e.g. from the soil surface. Potato ET_c can be estimated using weather data and is the amount of water to be replenished during the growing season in order to assure potential tuber yields at a given site. Potato ET_c is important to consider in irrigation planning and its use in irrigation scheduling is a well-developed strategy to improve the effectiveness of irrigation

Soil samples were taken from different soil layers before and after each irrigation time to determine water consumptive use through the interval irrigation time according to Israelson and Hansen (1962) as follows:

$$WCU_m = \frac{\sum_{i=1}^{i=n} \theta_{ai} - \theta_{bi}}{100} x \gamma_{si} x Z_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where :-

$\square_{ai}$ = soil moisture content after irrigation, % (BW);

$\square_{bi}$ = soil moisture content before irrigation, % (BW);

$\square_{si}$ = soil bulk density and

Z_i = depth of soil layer.

Seasonal water consumptive use was calculated from the sum of WCU_m for all irrigation times. Measurement of soil water content was measured daily by TDR probes before and after irrigation. Three TDR groups were installed 12.5 cm to the left, 12.5 cm to the right, and close to the emitter (middle). Each TDR group had two probes installed vertically 20 and 40 cm from the surface.

Irrigation water use efficiency, (IWUE):

Irrigation water use efficiency was determined according to *James (1988) Zhang et al., (1999)* as follows:

$$IWUE = \frac{Y}{AIW} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where :-

IWUE = irrigation water use efficiency, kg/m^3 ;

Y = total tubers yield, kg/fed. and

AIW = Seasonal applied irrigation water, m^3/fed

Water application efficiency, (Ea):

Water application efficiency was calculated as the percentage of between the WCU and AIW (Michael, 1978).

RESULTS and DISCSSION

Total applied water:

The goal of irrigation scheduling is to get water into the root zone, maintain consistent water content in the root zone, and avoid pushing excessive amounts of water below the root zone. Irrigation water for each treatment during the growing season are shown in Fig. 3. Data on the amount of applied irrigation water indicated that, daily irrigation intervals required less water than other irrigation intervals because the total irrigation time (hours) per season was more in case of daily irrigation . As shown in Fig. 3. The average values of applied irrigation water were 2338, 2486, 2480 and 2490 m^3/fed./season for irrigation intervals every 1, 2, 3 and 4 days, respectively.

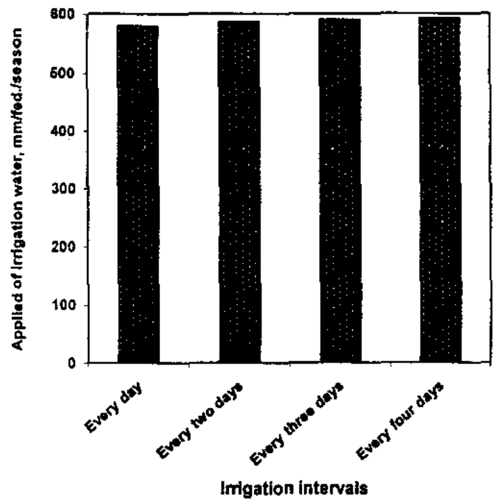


Fig. 3: Relationship between irrigation interval and total applied water.

Drainage water.

Drainage water from the root zone of potato grown on a sandy soil was collected from every pot (treatment) and measured by using calibrated cylinder. Sandy soil is made up of very large, slick soil particles, so water passes through it quickly, often carrying away nutrients before plants have a chance to use them. To modify this tendency, enrich sandy soil with organic matter and plan to use a little more fertilizer when growing plants that are heavy feeders. In soils dominated by large pores (i.e., sandy soils), water moves rapidly. Soils that allow rapid leaching (water movement down through the soil profile) also pose environmental hazards since rain or irrigation water moving through the soil profile takes water-soluble pollutants with it. Ground water pollution is a sensitive issue on coarse-textured sandy soils. The collected data revealed that, the average value of drainage water from experiments decreased by increasing rice straw-soil ratio as shown in fig. 4. The results indicates the maximum values were obtained with four days irrigation interval at sandy soil without rice straw pieces. The average values of irrigation water drainage were 573, 387, 261, 158 and 80 m^3/fed./season for 0.00, 0.10, 0.20, 0.30 and 0.40 rice straw-soil ratio, respectively. Irrigation drainage water increased by about of 62.30, 197.39 and 283.37% for irrigation intervals every 2, 3 and 4 days, respectively comparing with every day irrigation interval. It is clear that, increasing rice straw-soil ration tends to increase soil holding capacity as shown in fig. 4.

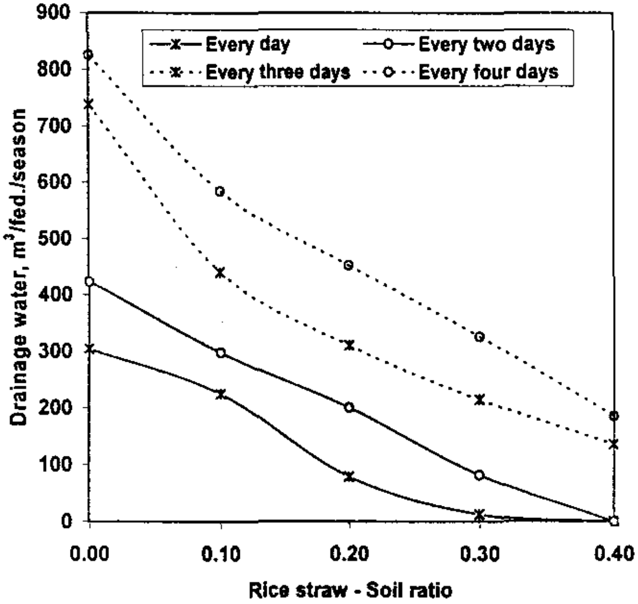


Fig. 4: Effect of rice straw-sandy soil ratio on drainage irrigation water.

Water consumptive use :

For irrigation the soil water storage (SWS) capacity is defined as the total amount of water that is stored in the soil within the plant's root zone. Knowing the soil water storage capacity allows the irrigator to determine how much water to apply at one time and how long to wait between each irrigation. Applying more water to the soil than can be stored results in a loss of water to deep percolation and leaching of nutrients beyond the root zone. The amount of water retained by a sandy soil increased by 23 and 95% by adding small amounts of rice straw pieces to the soil as shown in fig. 5. The average values of water consumptive use were 19.97, 16.76, 22.39 and 26.44% for straw-soil ratios 0.1, 0.2, 0.3 and 0.4, respectively comparing to water consumptive use in sandy soil without added rice straw pieces. The average values of water consumptive use were 551, 532, 492 and 467 mm/season for every day, every two days, every three days and every four days, respectively. The maximum value of water consumptive use was 580 mm/season that obtained with 0.3 and 0.4 straw-soil ratio for four days irrigation interval. It is clear that, increasing rice straw-soil ration tends to increase soil holding capacity as shown in Fig. 6.

Soil field capacity increased by 26.63, 27.61, 59.83 and 107.68% for rice straw-soil ratio 0.1, 0.2, 0.3 and 0.4, respectively comparing with field capacity for sandy soil.

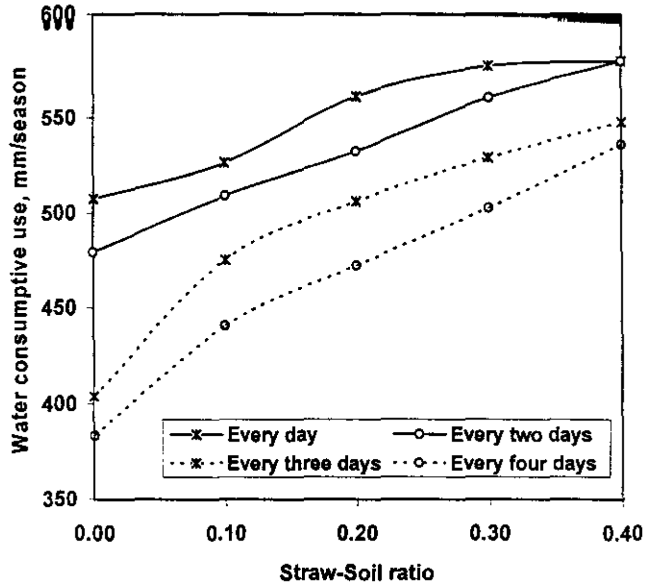


Fig. 5: Effect of rice straw-sandy soil ratio on irrigation water consumptive use.

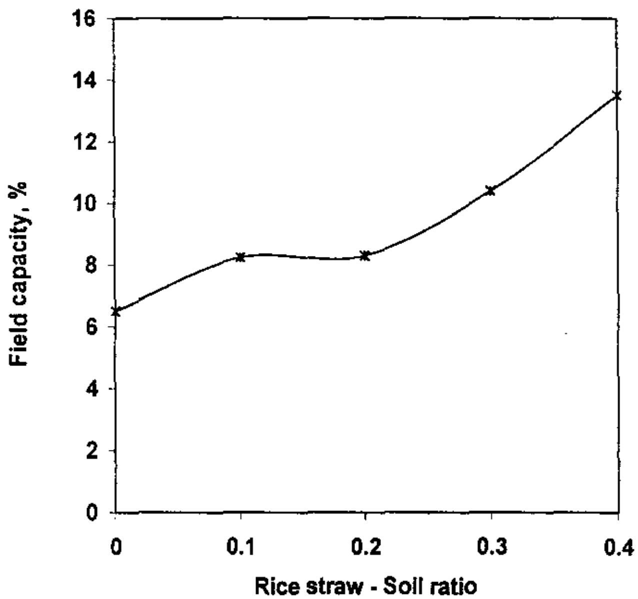


Fig. 6: Effect of rice straw-sandy soil ratio on soil field capacity.

Water application efficiency:

Application efficiency as used here is defined as the depth or volume of water added to the root zone store expressed as a ratio of the depth or volume of water applied to the field. The results indicated that, increasing rice straw-soil ratio tended to increase water application efficiency. The application efficiency values were 75.61, 83.11, 88.24, 92.37 and 95.53% for rice straw-soil ratios 0.00, 0.10, 0.20, 0.30 and 0.40, respectively. Irrigation every day gave the highest values of water application efficiency because increase irrigation intervals tended to increase deep percolations (water drainage). The maximum value of water application efficiency was 100 % for 0.40 rice straw-soil ratio and irrigation every day as shown in fig. 7..

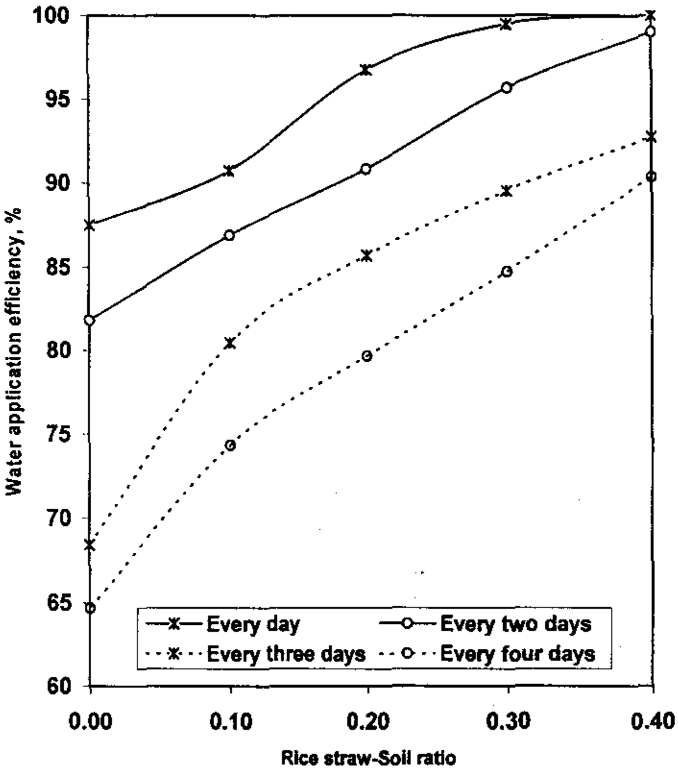


Fig. 7: Effect of rice straw-sandy soil ratio on water application efficiency.

Tubers yield:

Potato production is increasing worldwide, particularly production of potato for processing into frozen convenience or food service products. There was difference in potato production with irrigation intervals and added rice straw pieces into sandy soil. Total potato tuber yields are illustrated in fig. 8. The average values of tuber yield were 5.78, 6.43, 7.67, 9.03 and 11.29

Mg/fed. for straw-soil ratios 0.00, 0.10, 0.20, 0.30 and 0.40, respectively. The average values of tuber yield were 7.93, 9.56, 8.36 and 6.30 Mg/fed. for every day, every two days, every three days and every four days, respectively. The maximum value of tuber yield was 13.82 Mg/fed. that obtained with 0.40 rice straw-soil ratio and every three days irrigation interval. The potato yield was increased by 11.29, 32.76, 56.21 and 95.46% for rice straw-soil ratio 0.10, 0.20, 0.30 and 0.40 comparing with production under sandy soil without added rice straw pieces which, the potato yield in case of sandy soil was 5.78 Mg/fed.

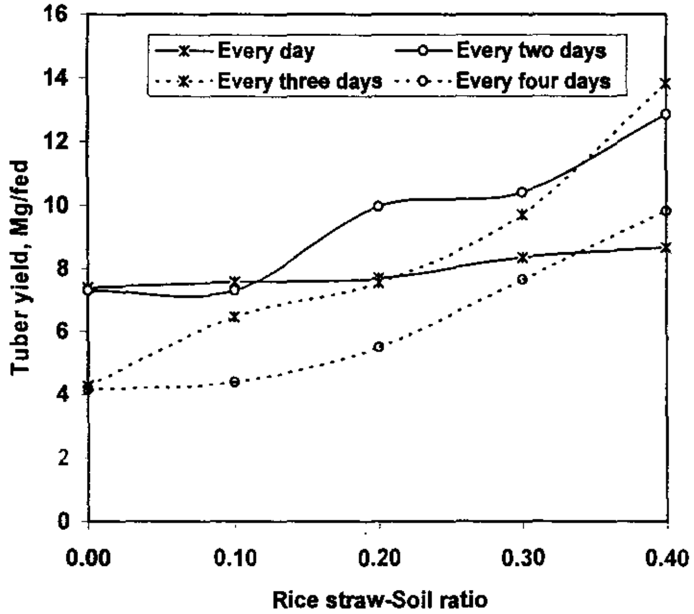


Fig. 8: Effect of rice straw-sandy soil ratio on potato yield.

Irrigation water use efficiency:

Efficiently controlling soil water content with irrigation is essential for water conservation and often improves potato yield. Efficient irrigation water management provides adequate soil water for crop root uptake while optimizing irrigation water use efficiency (IWUE) and reducing losses of N and other production inputs through leaching. The results in fig. 9 indicate that, increasing rice straw-soil ratio tended to increase irrigation water use efficiency. The values of irrigation water use efficiency were 3.05, 3.11, 3.51, 3.96 and 4.80 kg/m^3 for rice straw-soil ratios 0.00, 0.10, 0.20, 0.30 and 0.40, respectively. Irrigation every day gave the highest values of water application efficiency because increase irrigation intervals tended to increase deep percolations (water drainage). The maximum value of water application efficiency was 6.01 kg/m^3 for 0.40 rice straw-soil ratio and irrigation every three days.

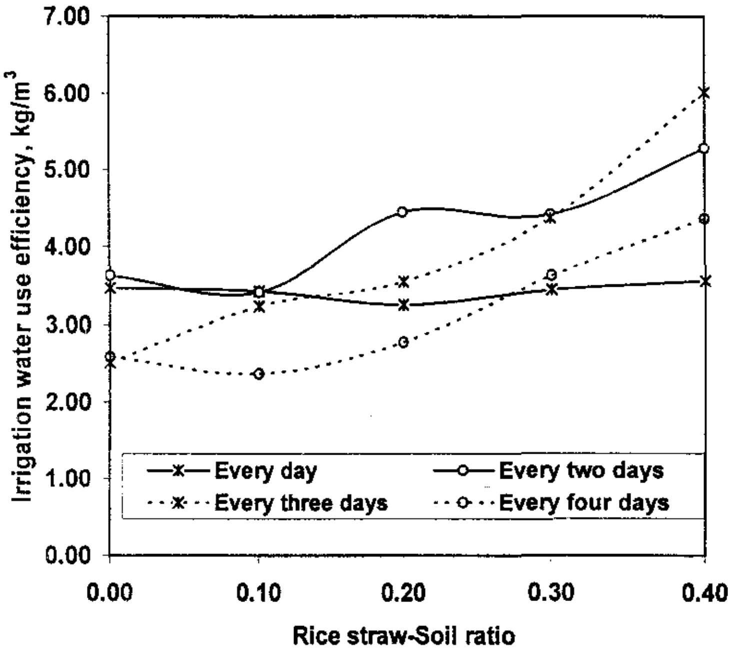


Fig. 9: Effect of rice straw-sandy soil ratio on irrigation water use efficiency.

Leaf area index (LAI)

Leaf area index is a dimensionless value. The interaction between vegetation surface and the atmosphere, e.g. radiation uptake, precipitation interception, energy conversion, momentum and gas exchange, is substantially determined by the vegetation surface. Measurement of leaf area index (LAI) is important in studies of plant growth. Leaf area index values were 3.05, 3.18, 4.10, 4.39 and 496 for straw-soil ratios 0.00, 0.10, 0.20, 0.30 and 0.40, respectively. The average values of leaf area index were 4.07, 4.50, 3.98 and 3.21 for every day, every two days, every three days and every four days, respectively as shown in fig. 10. The lowest value of leaf area index was 2.02 that obtained with 0.00 rice straw-soil ratio and every four days irrigation interval. The relationship between leaf area index and total potato yield indicates in fig. 11. It is clear that increasing leaf area index tended to increase yield production of potato tubers.

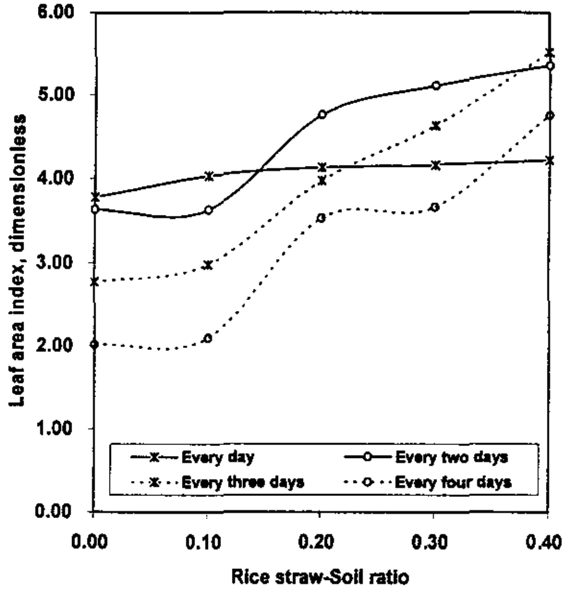


Fig. 10: Effect of rice straw-sandy soil ratio on leaf area index.

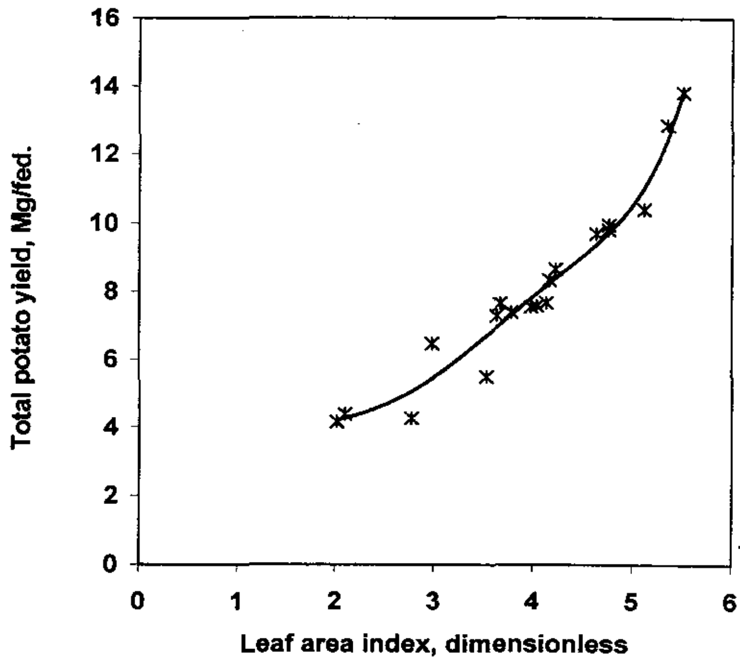


Fig. 11: The relationship between leaf area index and potato yield.

Conclusions

Add pieces of rice straw into the sand contribute to the solution of the problem of rice straw, which appear in Egypt during the harvest season of rice. And also helps to increase the cultivated area of land reclaimed sand due to the limited availability of water for irrigation in Egypt. Inaccurate moisture readings will lead to improper irrigation decisions. False-high moisture readings will result in deficit irrigation, which dramatically reduces yield and quality. False-low moisture readings will result in too much water being applied, which results in unnecessary losses of: water, power (for irrigation pump); yield; tuber quality; nutrients and chemicals. The combination of these losses results in reduced grower profits. Improving water use efficiency there were greater yields and greater reductions of nitrate leaching. Potato production and irrigation use efficiency were increased by mixed rice straw pieces into sandy soil because the rice straw improved the holding capacity of sandy soil. The highest values of potato tubers yield and IWUE were obtained with 0.40 rice straw-soil ration and three days irrigation intervals.

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تحسين كفاءة استخدام مياه الري لإنتاج محصول البطاطس تحت ظروف الأراضي الرملية

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الهدف من إدارة الري خلال موسم نمو محصول البطاطس هو محاولة المحافظة على المحتوى الرطوبي للتربة لعمق ٠ – ٦٠ سم بين السعة الحقلية ونقطة الذبول الدائم كذلك تقليل المياه الزائدة التي تؤدي إلى إزالة العناصر الغذائية مع مياه الصرف أيضا تجنب تعرض التربة إلى نقص الرطوبة عن نقطة الذبول مما يؤثر على نمو وإنتاجية المحصول. ولقد أجريت التجارب بإضافة قش الأرز المقطع إلى التربة الرملية لتحسين كفاءة مسك التربة لمياه الري وتم تنفيذ التجارب داخل الصوبة خلال الموسم الزراعي ٢٠٠٦/٢٠٠٧ (أكتوبر إلى يناير) في مركز أبحاث الأراضي القاحلة ، وجامعة توتوري ، اليابان. و اشتملت الدراسة على

١- فترات الري : تم استخدام أربع فترات ري (كل يوم ، كل يومين ، كل ثلاثة أيام كل أربعة أيام)
٢- نسبة إضافة قش الأرز إلى التربة، الرملية : تم استخدام خمسة نسب خلط مختلفة (٠ و ١٠ و ٢٠ و ٣٠ و ٤٠ ٪ من حيث الحجم).

الهدف من هذا البحث هو زيادة قدرة التربة الرملية على الاحتفاظ بمياه الري مما يحسن من كفاءة استخدام مياه الري لمحصول البطاطس.

وكانت أهم النتائج المتحصل عليها من التجارب هي :-

- ا أقصى قيمة استخدمت من مياه الري كانت ٥٨٠ مم / موسم وذلك عند استعمال نسبة خلط ٣٠ و ٤٠% كنسبة خلط بين قش الأرز و التربة الرملية باستعمال الري بالتنقيط كل أربعة أيام كفترات ري.
- أوضحت النتائج أن مياه الصرف زادت بنحو ٦٢,٣٠ ، ١٩٧,٣٩ و ٢٨٣,٣٧ % وذلك عند الري على فترات يومين وثلاثة أيام وأربعة أيام ، على التوالي مقارنة مع الري كل يوم.
- الري كل يوم أعطى أعلى القيم لكفاءة إضافة مياه الري نظرا لان زيادة فترات الري تؤدي إلى زيادة كمية المياه المضافة في الرية الواحدة مما يؤدي إلى زيادة في حركة مياه الري لأسفل خارج مجال الجذور (مع مياه الصرف).
- إنتاجية محصول درنات البطاطس التي تم الحصول عليها من التجارب كانت ٧,٩٣ – ٩,٥٦ – ٨,٣٦ و ٦,٣٠ طن/فدان وذلك لفترات ري كل يوم – كل يومين – كل ثلاثة أيام و كل أربعة أيام على التوالي.
- أوضحت النتائج انه بزيادة نسبة خلط قش الأرز مع التربة الرملية أدى إلى زيادة كفاءة استخدام مياه الري وذلك عند جميع فترات الري وذلك لانخفاض مياه الري التي تتصرف خارج مجال الجذور بزيادة نسبة الخلط بين قطع قش الأرز والتربة الرملية..