Assessment of Supplementary Irrigation Rate on Productivity of Potato (Solanum tuberosum L.) in Kuru, Jos, Northern Guinea Savanna, Nigeria

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Abstract- A two year study on the assessment of the effects of supplementary irrigation (SI) and variety on the productivity of potato (Solanum tuberosum L.) was conducted during the 2017 and 2018 cropping seasons at the Research Farm of the National Root Crops Research Institute (NRCRI) Kuru, Jos in Plateau State, Nigeria. The treatments consisted of two varieties of potato (improved variety (Daimat) and local variety and four levels of water application (W1 = No SI, W2 = SI of 200 mm, W3= SI of 400 mm, W4 = SI of 600 mm). The factors were combined to give 8 treatments and were laid out in a 2×4 split – split plot arrangement in a Randomized Complete Block Design (RCBD) and replicated three times. Crop data collected were percent germination, plants height, leaf area, number of leaves, number of branches, number stems, stem girth, number of tubers per plant, number of seed tubers per plant, number of ware tubers per plant, weight of seed tubers per plant, weight of ware tubers per plant and total yield of potato (tons/ha). Crop data collected were subjected to Analysis of Variance (ANOVA). Results on potato productivity showed that higher yield (13.57 tons/ha) and better agronomic traits were recorded under supplementary irrigation (irrespective of the variety) relative to the No SI (1.46 ton/ha.). The relationship between yield and SI was positive. A unit increase in SI resulted to increase potato yield by 3%. Daimat variety gave better (8.99 t/ha.) Yield of potato compared to the local variety which yielded (6.8 t/ha). Supplementary irrigation for the production of potato in the study area especially at the period of erratic rainfall is hereby recommended.

Index Terms- Productivity, Supplementary irrigation, Variety, Water use efficiency.

I. INTRODUCTION

Potato is the most fruitful and efficient tuber crop in the world in terms of tuber yield and days to maturity. It matures in about 60-90 days (2-3 months) as compared to 9 and 12 months of yam and cassava respectively [1]. It is one of the most important food crops of the world. Its probable centre of origin is in South America in Central Andean Region [2]. [3] reported that the crop was first introduced outside the Andes region four centuries ago, and have become an integral part of world's food consumption.

Supplementary irrigation is a temporal intervention, designed to influence when water is made available to augment natural evapotranspiration. It is irrelevant when daily rainfall is adequate to support crop growth, but there are frequent period of shortages, during which crop would die or yield would be substantially depressed by moisture shortage [4].

Field observations and rainfall pattern over the last few year's couple with uneven distribution in Nigeria indicate that early season drought has become serious limiting factors in agricultural production especially in northern Nigeria either by delaying planting or causing severe moisture stress in young seedling. Climatic data of the study area in the last ten years (2006-2016) depicts the erratic nature of rainfall in the area [5]. The data also shows that rainfall has been fluctuating especially in the months of April and May (suitable planting periods of potato) as reported by [3].

Relative humidity on the other hand has been on the increase progressively through the season each year from January to October where it starts to drop [5]. This increased in relative humidity is one of the favourable conditions for the activities of potato blight which can cause 100 % damage to potato on famers' field. [6] collaborated this fact when he reported that late potato blight caused by fungus (*Pythopthora infestans L)* attack potato as from July.

The need for artificial application of water to the soil to supplement or replace rainfall, lengthen the cropping season and thereby, help to create optimum conditions for crop growth and development is very vital [5].

This study is intended to offset the negative effect of dry spell as usually experienced by potato farmers so as to improve the yield of the crop in the study area.

The major aim of this study is to assess the effect of supplementary irrigation on potato in Kuru area of Jos-South, Plateau state

1.1 The specific objectives of the study are to:

1. determine the effect of different rates of supplementary irrigation on the growth and yield of potato.
2. evaluate the effect of variety on potato productivity
3. assess the influence of supplementary irrigation and variety on water use efficiency of potato.

II. MATERIALS AND METHODS

2.1 Site Description and Characteristics

The field experiment was conducted at the Research Farm of the Potato Program, National Root Crops Research Institute, Kuru ($09^0 44^l$ N,$08^0 47^l$E, elevation 1,236.3 m a.m.s.l.) Jos, Plateau State. The soil of the study site belongs to the soil order Alfisols [7] of the basement complex volcanic rocks origin and has a sandy loam texture at the surface. It is slightly acidic to neutral. Mean rainfall is about 1500 mm received in 130-150 days from May to September [8]. It has a maximum temperature of 27 ^{0}C and a minimum temperature of 10 ^{0}C. The dominant Vegetation at the site includes guinea grass (*Panicum* maximun), gamba grass (*Andropogon gayanus*) and elephant grass (*Penisetum pueperum*) [9].

The climate is characterized by two distinct wet and dry seasons. The wet season starts from late April and end in October while the dry season starts from November to mid-April. It is located within the northern guinea savanna agro-ecological zone of Nigeria [10]. The map of Plateau State and map of the study area are presented in figure 1 and 2 respectively.

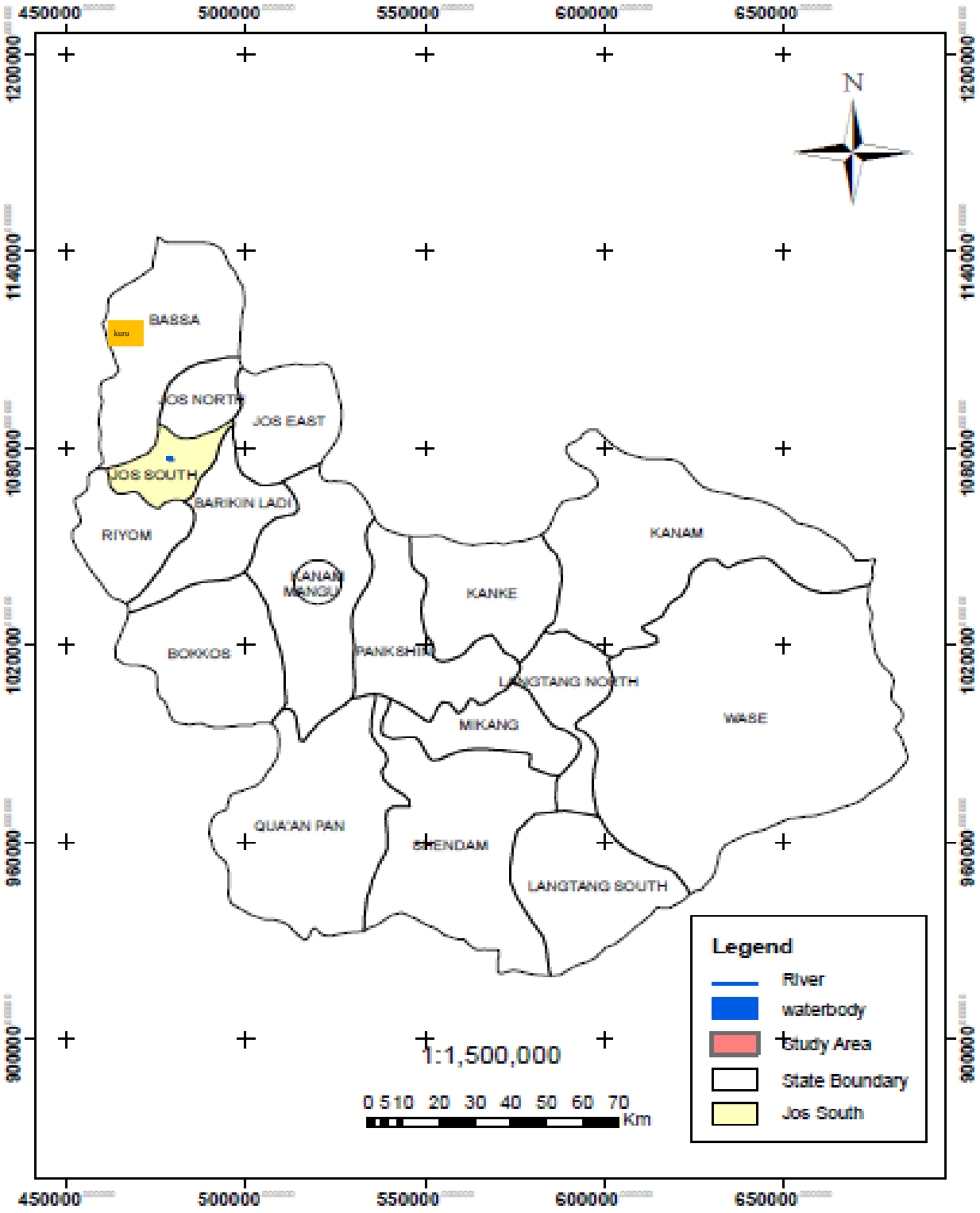

Figure 1: Map of Plateau state showing Kuru, Jos [11]

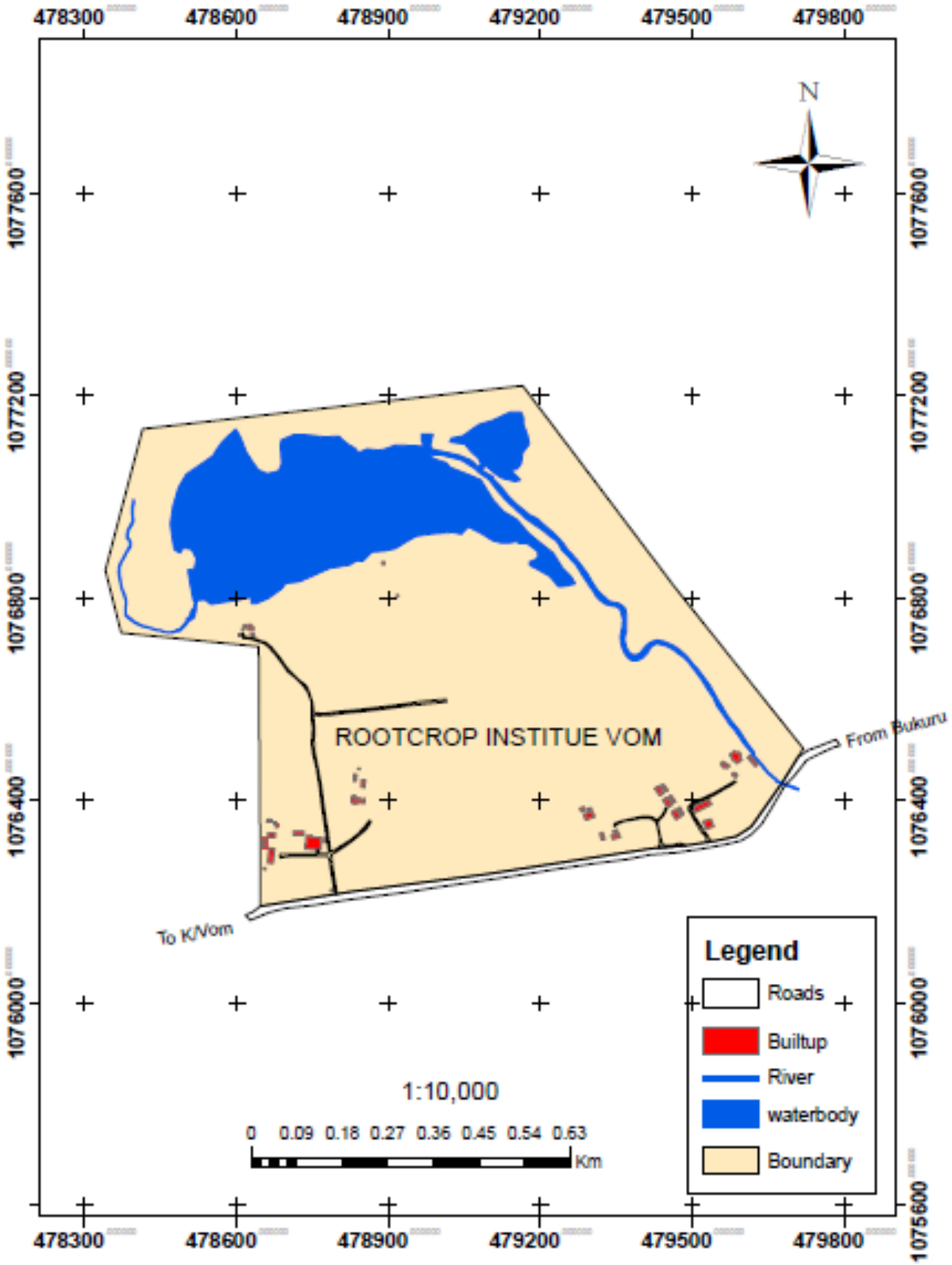

Figure 2: Map of the Study Area [11]

2.2 Experimental Treatments and Design

The treatments consist of two varieties of potato: V_1(Daimat; improved variety), and V_2(Local variety) and four levels of water application: W_1(control; No Supplemental irrigation), W_2 (supplemental irrigation of 200 mm - W_3 (Supplemental irrigation of 400 mm) and W_4 (supplemental irrigation of 600 mm).

The factors where combine to give a total of 8 treatment combinations as follows;

$T_1 = V_1W_1$ $T_5 = V_2W_1$

$T_2 = V_1W_2$ $T_6 = V_2W_2$

$T_3 = V_1W_3$ $T_7 = V_2W_3$

$T_4 = V_1W_4$ $T_8 = V_2W_4$

The treatments were laid out in a 2 x 4 split – split plot arrangement in a Randomized Complete Block Design (R C B D) and replicated three (3) times. Each sub plots area had a dimension of 2 m x 3 m (6 m^2) separated by 1 m

2.3 Agronomic Practices

2.3.1Land clearing and sowing

The vegetation was manually cleared. Ploughing, harrowing and ridging were done mechanically. Seeds were sourced from NRCRI Vom. Sowing was done at 30 cm x 100 cm (33,333 plants per ha). Planting was done in 2nd week of April and 2nd week of May.

2.3.2 Application of Supplementary Irrigation

Application of supplementary irrigation was achieved through monitoring of soil moisture content. Level furrows were created between rows to ensure uniform distribution of water in irrigated plots. Furrows were closed to prevent runoff and a flow meter was used to measure the amount of applied water. Furrows not used for irrigation were dammed and at least one dammed furrow was created between two irrigated ones.

The greatest number of potato roots is located at 30 cm soil depth up until flowering and increase to 60 cm depth during tuberization [12].

Therefore, tensiometers were installed in the field to monitor the available moisture range at the soil depth of placement of 46 - 51 cm to reflect the effective rooting depth of potato [12]. Supplementary irrigation levels of 0, 200, 400 and 600 mm were applied to the respective plots when the available moisture content were below their expected range

2.3.4 Fertilizer Application and Weed Control

NPK fertilizer was applied at 90 kgN – ha^{-1}, 60 kg P_2O_5 ha^{-1}, 120 kg K_2O ha^{-1} at 5 WAP. Weed control was done manually using small hoe at regular intervals to keep the field free of weed.

2.4 Data Collection

2.4.1 Climatic data

Meteorological data including daily rainfall, sunshine hours, maximum and minimum temperature and air humidity were obtained from the Meteorological Station of National Root Crops Research Institute (NRCRI) Vom.

2.4.2 Crop data

Seedlings count was done four (4) weeks after planting (WAP). The number of seedlings per plot was expressed as percentage of the number of seeds planted. Five plants were selected randomly at the two centre rows of each plot and tagged for growth and yield data determination. Number of day to 60 % flowering was also taken. Plant heights were measured using measuring rule, measuring the height of plant from the base to the tip of growing point. Number of branches, number of leaves, leaf area and stem girth were taken at 4, 6,8,10 and 12 WAP. Yield parameters taken include number of seed tubers per plant; number of ware tubers per plant (kg/plant), weight of seed tubers per plant, weight of ware tubers per plant (kg/plant) and total yield in t/ha.

The leaf area index was calculated for each sampling data as:

$$\frac{\text{Total leaf area } (cm^2) \text{per stand(2 plants)}}{\text{Area of land available for plant } (300m^2)} \quad \ldots\ldots 1$$

Number of branches and number of leaves per plant were taken by counting. Stem girth was determined using thread and rule. Number of days to maturity was also noted.

2.5 Statistical Analysis

Data generated were subjected to analysis of variance (ANOVA) using GenStat. Means that were statistically significant were separated using Least Significant Difference (LSD) according [23]. Regression was carried out to assess the relationship between yield and planting date, variety and amount of water application and water use efficiency.

III. RESULTS

3.1 Climatic Data for the Study Area

Some meteorological data for Kuru during the period of study are presented in Table 1. The annual rainfall during the period of study ranged between 13. 5 – 308. 7 mm from March to August. The highest amount of rainfall (308.7 mm) was recorded in the month of August in 2017 while the least amount of rainfall was recorded in the month of March (13.5 mm). The total annual rainfall in 2017 stood at 1588 mm while the mean annual rainfall was 132 mm. The maximum temperature (30 ^{0}C) was recorded in the month of March and the least temperature (12 ^{o}C) in the month of December. Relative humidity varies from 31 % in January to 84 % in August. The sunshine was highest (277.3 hrs.) in February while the least (68 hrs.) was obtained in the month of September.

In 2018, the highest amount of rainfall (283.3mm) was observed in July while the least (10.05 mm) rainfall was in February (Table 4). The total rainfall for 2018 was1525.25 mm while the mean rainfall for the period of study in 2018 was 1127.10 mm. Temperature varies from 22 ^{0}C (lowest) to 26 ^{0}C (highest). Relative humidity varies from 18 % in January to 80 %. The highest amount of sunshine (276.6 hrs.) was recorded in January while the least amount of sunshine (148.2 hrs.) was low recorded in the mount of July.

3.2 Effects of variety and supplementary irrigation (SI) rate on percent germination and plant height of potato

The main effects of variety and SI rate on percent germination and plant heights of potato are presented in Table 2. Variety did not affect percent germination in 2017 and 2018 planting seasons.

Germination percentage did not show any variation as a result of varietal difference. This implies that if there is sufficient moisture in the soil, germination rate may not be a problem.

There was significant ($P < 0.05$) effect of SI rate on percent germination in 2017 and 2018. SI rate of 200 mm gave the highest percent germination of 95.5% followed by SI rate of 400 mm which gave 93.33% while the no supplementary irrigation (No SI) rate gave the least percent germination of 68.33% in 2017. The results showed similar trend in 2018 with 200 mm of SI rate having the highest percent germination rate of 96.5 % followed by SI rate of 400 mm with 94.33 percent while the No SI treatments gave the least percent germination of 69.42% (Table 2).

Moisture has high significant ($P < 0.05$) influence on percent germination. Poor germination percentage presented by No SI could be due to drought setting in after planting. Plant height was not dependent on variety in the two years research. The adaptation of the varieties in the study area may be due to favourable environmental factors especially temperature (Kashap and Panda, 2003).

The results of the effects of variety and No SI rate on the height of potato are presented in Table 2.

Variety did not affect plant height both in 2017 and 2018.

No SI rate significantly ($p < 0.05$) affected plant height in 2017 and 2018 planting seasons. At 6 WAP, SI rate of 600 mm gave the highest plant height of 24.21 cm followed by SI of 400 mm which gave plant height of 22.0 cm. The least plant height of 6.57 cm was recorded under the no SI rate. At 8 and 10 WAP, the performance followed the same trend with SI rate of 600 mm producing taller plants followed by SI rate of 400 mm while the least plant heights were observed under the No SI treatment in 2017. At 10 WAP, plant heights were tallest (30.02 cm) under the 600 mm SI rate followed by 400 mm SI rate with 28.14 cm plant height while the least plant height was 8.56 cm under the No SI treatments in 2017. Similar results were obtained in 2018. Supplemental water application of 600 mm favours plant heights compared to 400 mm, 200 mm and No SI. 3.3 Combined effects of variety and supplementary irrigation rate on percent germination and plant heights of potato in Kuru, Jos

The combined effects of variety and SI rate on percent germination and plant height is presented in Table 3.

Combined effects of variety x SI water did not affect percent germination significantly in 2017 and 2018 (Table 3).

There was significant ($P < 0.05$) combined effects of variety against SI rate on plant height of potato throughout the periods of observation in 2017 and 2018 except at 6 WAP in 2018 where no significant interaction effect was observed. The results showed that local variety (V_2) x 400 mm of SI gave higher plant height of 21.33, 26.33 and 26.85 cm at 6,8 and 10 WAP respectively in 2017 while same local variety (V_2) x No SI gave least plant heights of 5.28, 6.13 and 11.21 cm at 6,8 and 10 WAP respectively. In 2018, the results followed the same trend where local

variety (V_2) x 400 mm SI recorded higher plant heights throughout the periods of observation while same local variety (V_2) x No SI gave least plant heights both at 8 and 10 WAP.

3.3 Combined effects of variety and supplementary irrigation rate on percent germination and plant heights of potato in Kuru, Jos

The combined effects of variety and SI rate on percent germination and plant height is presented in Table 3. Combined effects of variety x SI water did not affect percent germination significantly in 2017 and 2018 (Table 3). There was significant ($P < 0.05$) combined effects of variety against SI rate on plant height of potato throughout the periods of observation in 2017 and 2018 except at 6 WAP in 2018 where no significant interaction effect was observed. The results showed that local variety (V_2) x 400 mm of SI gave higher plant height of 21.33, 26.33 and 26.85 cm at 6,8 and 10 WAP respectively in 2017 while same local variety (V_2) x No SI gave least plant heights of 5.28, 6.13 and 11.21 cm at 6,8 and 10 WAP respectively. In 2018, the results followed the same trend where local variety (V_2) x 400 mm SI recorded higher plant heights throughout the periods of observation while same local variety (V_2) x No SI gave least plant heights both at 8 and 10 WAP.

The results implied that SI water of 400 mm is adequate for the production of both improved (Daimat) and local variety of potato.

3.4 Effects of variety and supplementary irrigation rate on number of leaves and leaf area of potato at Kuru, Jos

The results of main effect of variety and SI rate on number of leaves and leaf area of potato are presented in Table .

Variety had no significant effect on number of leaves of potato in 2017 and 2018 planting seasons.

Variety influences leaf area at early growing stages (6 and 8 WAP) but decrease later as the crop ages in both seasons. Leaf expansion in the improved variety was better compared with the local variety. This implies that the improved variety probably had better photosynthetic activities compared to the local variety.

Effect of SI rate on number of leaves was highly significant ($p < 0.05$) throughout the periods of observation in 2017 and 2018. In 2017, SI rate of 600 mm produced more number of leaves (11.67, 11.72 and 12.67) at 6, 8 and 10 WAP respectively, followed by SI rate of 400 mm which produced 9.92, 10.50 and 11.52 number of leaves at 6, 8 and 10 WAP respectively. The least number of leaves were produced under the No SI condition with 4.15, 4.17 and 5.12 number of leaves produced at 6, 8 and 10 WAP respectively. The results in 2018 followed the same trend where more number of leaves were produced under the SI rate of 600 mm, followed by SI rate of 400 mm while the least number of leaves where produced under the No SI condition.

The results showed that leaf area was not significantly affected by variety in 2017 and 2018.

SI rate effects was highly significant ($p < 0.05$) on leaf area of potato in 2017 and 2018 throughout the periods of observation. Potato plants had more area of leaves (20.12 cm^2 and 23.12cm^2 and 23.12 cm^2) at 6, 8 and 10 WAP respectively under SI rate of 600 mm followed by 13.81cm^2, 19.11 cm^2 and 19. 40 cm^2 of leaf area at 6, 8 and 10 WAP respectively under the SI rate of 400 mm while least leaf area of 6.20 cm^2, 7.21 cm^2 and 7.89 cm^2 were produced at 6, 8 and 10 WAP under the No SI in 2017. In 2018, the trend was the same where 600 mm of SI rate gave higher leaf area followed by SI rate of 400 mm while the least leaf area was produced under the No SI condition.

Moisture influenced number of leaves and leaf area significantly ($P < 0.05$) in both cropping seasons. SI of 600 mm favourably affected number of leaves and leaf area throughout the plant development stages in both seasons compared to 400 mm, 200 mm and the control respectively.

3.5 Combined effects of variety and supplementary irrigation rate on number of leaves and leaf area of potato at Kuru.

The interaction of variety × SI rate effect was significant ($p < 0.05$) on number of leaves at 8 WAP in 2017 and 2018 at 6 WAP. In 2017 planting of Daimat variety (V_1) x 400 mm SI had more and equal number of leaves (11.67) while local variety (V_2) x No SI produced least number of leaves (5.5). In 2018, local variety x 400 mm SI recorded more number of leaves (10.12) while local variety x No SI had least number of leaves. Both the improved (Daimat) and local gave more number of leaves when combined with 400 mm SI relative to the combination of No SI on both varieties.

The interaction effect of variety x SI rate on leaf area was significant ($p < 0.05$) at 6 and 8WAP in 2017 and 2018. However, at10 WAP, the interaction effect was not significant in both seasons (Table 5). At 6 WAP, Daimat variety (V_1) x 400 mm SI gave higher leaf area of 17 23 cm^2 and 17.25 cm^2 in 2017 and 2018 respectively. However, local variety (V_2) x 400 mm SI produced higher leaf area of 23.30 cm^2 and 23.40 cm^2 at 8 WAP in 2017 and 2018 respectively. Local variety (V_2) x No SI gave least leaf area of 4. 88 and 7.88 cm^2 at 6 and 8 WAP respectively.

Similarly, local variety (V_2) x No SI gave least leave area of 4.85 cm^2 and 7.88 cm^2 at 6 WAP and 8 WAP respectively in 2018 (Table 5). Results showed that improved variety appeared to respond better when combined with 400 mm SI than the local variety.

3.6 Effects of variety and supplementary irrigation rate on number of branches and number of stems of potato at Kuru, Jos

The main effect of variety and SI rate on number of branches, number of stems and stem girth of potato is presented in Table 6.

Variety had no significant effect on number of branches of potato in 2017 and 2018 (Table 6).

SI rate had significant ($P < 0.05$) effects on the number of branches of potato in 2017 and 2018 throughout the periods of observation. In 2017, SI rate of 600 mm produced 3.86, 3.90 and 4.01 number of branches of potato at 6 WAP, 8 WAP and 10 WAP respectively. The least number of branches (2.35, 2.55 and 2.86) of potato were produced under the No SI at 6, 8 and 10 WAP respectively. The results showed the same trend in 2018 (Table 6). It was observed that the number of branches increases as the SI rate increased.

Table 6 shows that variety did not have significant effect on number of stems of potato both in 2017 and 2018 planting seasons.

Effects of SI rate were highly significant ($P < 0.05$) on number of stems of potato throughout the periods of observation in 2017 and 2018. In 2017, more stem numbers (3.44, 3.54, and 3.73) were produced under the 600 mm SI rate at 6, 8 and 10 WAP. The least number of stems 2.91, 3.05 and 3.56 were produced under the No SI rate at 6, 8 and 10 WAP respectively.

It was observed that in 2017, the number of stem increases as the SI rate increased. The order was: 600 mm SI > 400 mm SI > 200 mm > No SI. In 2018, SI application of 400 mm gave more number of stems than all the other rates throughout the periods of observation. No SI application gave the least number of stems throughout the assessment periods (Table 6). The order of number of stems as affected by rate in 2018 was: 400 mm SI > 200 mm SI > 600 mm SI > No SI.

3.7 Combined effects of variety and supplementary irrigation rate on number of branches and number of stems of potato in Kuru

Table 7 shows that there was significant interactive effects of variety x SI rate on number of branches of potato at 6 and 8 WAP both in 2017 and 2018 but there was no significant effects of the interaction at 10 WAP both in 2017 and 2018 seasons. At 6 WAP, the interaction of local variety (V_2) x 400 mm SI rate gave more (4.00) number of branches of potato whiles the least (2.67) number of branches of potato were obtained under the interactive effects of Diamat variety (V_1) x No SI. Similar results were obtained in 2018 planting season.

Variety x SI had significant ($p < 0.05$) effects on number of stems of potato at 6 and 8 WAP both in 2017 and 2018 seasons. At 6 WAP, the more (4.00) stem numbers were obtained under the interaction effects of local variety × 400 mm rate of SI while the least (2.17) stem numbers of potato were obtained under the interaction effects of local variety × no SI. Similarly, at 8 WAP the higher number of stems were obtained under the interaction effect of local variety × SI rate of 400 mm while the least number of stems of potato were obtained under the interaction effect of local variety × No SI rate (Table 7).

3.8 Effect of Varity and supplementary irrigation rate on number of tubers/plant, number of seeds tubers/plant and number of ware tubers/plant of potato at Kuru, Jos

The results of Variety and SI rate on number of tubers/plant, number of seed tubers/plant and number of ware tubers/plant of potato is presented in Table 8. Number of tubers per plant was not affected by variety in 2017 but there was a significant ($p < 0.05$) effect of variety on number of tubers per plant in 2018. Diamat variety (V_1) gave more (4.04) number of tubers compared to local variety (V_2) which produced 3.26 number of tubers. Number of seed tubers per plant and number of ware tubers per plant were not affected by variety in 2017 and 2018.

SI rate had high significant ($p < 0.05$) effects on number of tubers per plant, number of seed tubers per plant and number of ware tubers per plant in 2017and 2018. In 2017, the more number of tubers per plant (5.00) were produced less than 400 mm of SI application while the least number (1.17) of tubers per plant was produced under No SI. In 2018, the results follow similar trend with 400 mm of supplementary water application producing the more number of tubers per plant while the least number of tubers per plant was produced under No SI. Number of seed tubers produced per plant were 2.67 under 400 mm SI application followed by 2.56 number seed tubers produced under 600 mm of supplementary water application while the least number of seed tubers (1.08) was produced under the No in 2017. In 2018, 400 mm of supplementary water application yielded more number of tubers per plant (3.25) compared to 1.25 numbers of seed tubers per plant produced under No SI. The results for number of ware tubers per

plant shows that the more number of ware tubers produced per plant (2.33) was obtained under 400 mm of supplementary water application. The least number of ware tubers per plant (0) was produced under No SI in 2017. The results in 2018 were similar to the results obtained in 2017. More number of ware tubers of 2.25 tubers was obtained under 400 mm SI application. The least number of ware tubers (0) was produced under the no supplementary irrigation.

SI had high significant ($p < 0.05$) effect on number of tubers , number of seed tubers and number of ware tubers .400 mm supplementary irrigation treatments gave more number of the characters tested while the least were observed under no SI condition.

3.9 Combined effects of variety and supplementary irrigation rate on number of tubes /plant, number of seed tubers/plant and number of water tubers per plant

The results of the combined effects of variety and SI rate on number of tubers per plant, number of seed tubers per plant and number of ware tubers per plant are presented in Tables 9

Number of tubers of potato per plant was not significantly affected by the interaction effect of variety × SI rate in 2017. However, the interaction effect was significant ($p < 0.05$) in 2018 (Table 9). Local Variety × 400 mm SI rate gave more (6.0) number of tubers per plant whiles the least (1.17) number of tubers per plant were produced under local variety × No SI (Table 9). The results further showed that the interaction effects of planting date × variety × SI rate had significant ($p < 0.05$) effect on number of tubers per plant in both 2017 and 2018 seasons (Table 9). In 2017, the interaction effect of planting in April × local variety × 400 mm SI rate had more (8.00) number of tubers per plant. The least (0.67) number of tubers per plant were produced under the interaction effect of planting Diamat variety in May × No SI. In 2018, Diamat variety planted in April x 400 mm SI gave more (8.33) number of tubers/plant while variety Diamat x May x No SI gave least (1.00) number of tubers/plant.

Results in Table 9 shows that the interaction effect of variety × SI rate on number of ware tubers per plant was not significant in 2017 and 2018. Similarly, results showed that the interaction effect of planting date × variety × SI rate did not significantly affect the number of ware tubers per plant in 2017 and 2018 planting seasons (Table 9).

3.10 Effects of variety and supplementary irrigation rate on weight (kg) of seed tubers per plant, weight (kg) of ware tubers per plant and weight of tubers (t/ha) of potato at Kuru, 2017 and 2018

The effect of variety and supplementary irrigation rate on weight of seed tubers per plant, weight of ware tubers per plant and weight of tubers is presented in Table 10**.**

Variety did not significantly affect weight (kg) of seed tubers per plant and weight of ware tuber/plant. However, variety had significant ($p < 0.05$) effect on weight of tubers (t/ha) in 2017. Diamat variety gave 8.99 t/ha while local variety recorded least weight of 6.84 t/ha of tubers.

SI rate had significant ($p< 0.05$) effect on weight (kg) of seed tubers per plant in 2017 but did not show any significant effect in 2018. Application of 400 mm and 600 mm SI gave more weight (0.13 each) while No SI gave least (0.051) weight of seed per tuber. However, weight (kg) of ware tubers per plant and weight (t/ha) of potato were significantly ($p < 0.05$) affected by SI in 2017 and 2018. In 2017, the higher weight of 0.28 kg of ware tubers per plant was produced under 200 mm of SI rate. The least weight of 0 kg ware tubers per plant of potato was produced under the No SI rate. Similarly, in 2018, the highest weight of 0.17 kg ware tubers per plant was produced under the 200 mm of supplementary irrigation followed. The No SI produced the least weight of 0 kg of ware tubers per plant.

Higher yield of 14.09 t/ha was produced under 400 mm of supplementary water application followed by 7.17 t/ha produced by SI of 200 mm while the least yield of 1.49 t/ha was produced under the No SI in 2017. Similar trend was obtained in 2018 where the SI of 400 mm produced higher yield of 13.57 t/ha while the least yield of 1.46 t/ha was also produced under the no supplementary irrigation.

Varietal effect was less significant on weight of seed tubers and weight of ware tubers but there was significant effect of varieties on total yield (t/ha). On the other hand there was no effect of variety on any of the traits (weight of seed tubers per plant weight of ware tubers per plant and total yield (t/ha) during the 2018 cropping season.

SI showed high significance ($p < 0.05$) effects on weight (kg) of seed tubers per plant, weight (kg) of ware tubers per plant and total yield of potato in 2017. In 2018, significant response of weight (kg) of ware tubers per plant and yield (t/ha) was observed. In 2018, SI had no significant effect on weight of seed per plant.

In 2017, the yield obtained were SI of 200 mm (7, 08 kg/ha), SI of 400 mm (13.57 t/ha), SI of 600 mm (9.50 t/ha) while the No SI treatments had 1.49 (t/ha). In 2018, the yield was 7.17 t/ha of SI 200 mm, 14.09 t/ha of SI 400 mm and the No SI treatments also gave the least yield of 1.49 t/ha.

3.11 Combined effects of variety and supplementary irrigation rate on the weight (kg) of seed tubers per plant, weight (kg) of ware tubers per plant and weight (t/ha.) of tubers of potato at Kuru

The combined effects of variety and supplementary irrigation rate on yield of potato are presented in Tables 11 Results in Table 11shows that weight of tubers of potato was not significantly affected by the interaction of variety × SI rate both in 2017 and 2018 planting seasons

Table 1: Some Climatic Data for Kuru in 2017/2018

2017					
Month	**Rainfall** (mm)	**Temperature (^{0}c)**		**Relative humidity** (%)	**Sunshine** (hrs.)
		min.	max.		
January	0	13	27	31	252.8
February	0	16	30	25	277.3
March	13.5	18	31	34	240.8
April	96.2	20	28	59	189.5
May	143.8	19	28	71	186.4
June	202.3	18	25	80	150.2
July	214.8	18	23	81	123.8
August	308.7	17	22	84	770
September	256.3	17	25	78	68.3
0ctober	276	17	28	51	200.6
November	76.4	14	28	32	276.7
December	0	12	28	34	269.2
2018					
January	0	11	26	18	276.6
February	10.05	15	25	20	265.4
March	36	19	26	22	223.9
April	28	18	26	56	257.1
May	218.5	19	25	64	212.2
June	156.4	17	22	73	165.3
July	283.3	18	24	80	148.2
August	310.8	18.0	26.0	75.0	147.3
September	279.0	17.0	27.0	77.0	137.9
0ctober	196.0	17.0	29.0	62.0	184.4
November	7.2	13.0	30.0	23.0	369.3
December	0.0	12.0	27.0	17.0	278.4

Source: NRCRI Kuru Meteorological Station 2017/ 2018

Table 2: Main Effects of Variety and Irrigation Rate on Germination count and Plant Height of Potato at Kuru, Jos

	Germination Count (%)		2017 Plant Height(cm)			2018		
	2017	2018	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP
Variety								
V1 (Daimat)	85.54	86.42	17.35	19.02	19.56	16.25	19.00	19.46
V2 (Local Variety)	87.96	88.25	16.21	18.31	19.02	16.21	18.31	19.02
FLSD (0.05)	2.57	6.1	Ns	1.08	2.13	11.45	3.06	3.61
F-pr	0.059	0.325	0.821	0.98	0.59	0.51	0.81	0.43
Irrigation rate(mm)								
No Supplementary Irrigation (No SI)	68.33	69.42	6.57	8.02	8.57	6.56	8.05	8.55
200	95.5	96.5	16.1	19.97	21.13	16.02	19.87	20.93
400	93.33	94.33	22.0	26.00	28.14	22.12	26.10	28.54
600	89.83	89.08	24.21	28.13	30.02	24.31	28.23	30.12
FLSD (0.05)	4.45	4.38	2.06	1.02	1.24	7	0.96	0.84
F-pr	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VXW	NS	NS	3.43	1.49	2.3	NS	2.32	2.82

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5% level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation

Table 3: Combined Effects of Variety and Supplementary Irrigation Rate on Percent Germination and Plant heights of Potato in Kuru, Jos

Variety Vs	Irrigation rate (mm)	Germination Count (%)		Plant Height (cm) 2017			2018		
		2017	2018	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP
V1 (Daimat)	No SI	65.33	67.5	7.88	10.05	11.00	7.80	10.15	11.05
	200	96.33	97.67	17.02	20.63	21.40	17.05	20.03	21.40
	400	93.50	93.33	19.70	23.68	26.33	19.75	23.45	26.31
	600	87.00	87.17	`14.45	18.93	19.09	`14.35	18.90	19.19
V2 (Local Variety)	No SI	71.33	71.33	5.28	6.13	11.21	5.20	6.13	11.01
	200	94.67	95.33	15.25	19.25	21.34	15.15	19.20	21.35
	400	93.17	95.33	21.33	26.33	26.85	21.23	26.03	26.80
	600	92.67	91.00	16.02	19.85	20.09	16.10	19.81	20.10
FLSD (0.05)		5.74	5.80	3.43	1.49	2.30	10.47	2.32	2.82
F-pr		0.193	0.437	<0.001	<0.001	0.01	0.44	<0.001	<0.001

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5% level of probability, Ns = Not significant, Fpr = Probability value, SI = Supplementary Irrigation

Table 4 : Main Effects of Variety and Irrigation Rate on Number of Leaves and Leaf Area of Potato, at Kuru, Jos

	Number of Leaves						Leaf Area (cm^2)					
	2017			2018			2017			2018		
	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP
Variety												
V1 (Daimat)	7.57	9.21	9.77	7.57	9.18	9.67	12.84	14.83	15.02	12.54	14.33	14.98
V2 (Local Variety)	7.04	8.04	8.78	7.04	8.04	8.88	12.77	14.73	15.12	12.67	14.83	15.02
FLSD (0.05)	2.26	1.62	0.57	3.39	2.35	1.08	1.32	1.98	8.04	3.87	2.38	2.38
F-pr	0.92	0.79	1.00	0.81	0.89	1.00	<0.001	0.003	0.61	0.04	0.01	0.24
Irrigation rate(mm)												
No SI	4.15	4.17	5.12	4.25	4.18	5.12	6.20	7.21	7.89	6.21	7.11	7.89
200	7.17	7.92	8.67	7.16	7.52	8.66	9.84	10.11	13.87	9.83	10.11	13.87
400	9.92	10.50	11.52	9.04	10.10	11.62	13.81	19.11	19.40	13.81	19.21	19.40
600	11.67	11.72	12.67	10.57	11.62	12.67	20.12	21.321	23.12	20.02	21.3	21.52
FLSD (0.05)	1.12	0.5	0.76	0.51	1.12	0.76	1.62	1.63	2.93	1.76	1.76	2.14
F-pr	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VXW	NS	1.59	NS	2.82	NS	NS	2.51	2.51	NS	3.08	3.08	2.86

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation

Table 5: Interaction Effects of Variety x Supplementary Irrigation Rate on Number of Leaves and Leaf Area of Potato at Kuru, Jos

Variety Vs	Irrigation rate (mm)	Number of Leaves						Leaf Area (cm^2)					
		2017			2018			2017			2018		
		6WAP	8WAP	10WAP	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP
V1 (Daimat)	No SI	3.83	5.5	6.33	3.80	5.51	6.03	5.33	8.30	8.71	5.35	8.31	8.70
	200	7.00	8.00	8.67	7.05	8.05	8.57	10.75	14.77	16.70	10.70	14.75	16.71
	400	9.83	11.67	11.83	9.80	11.57	11.83	17.23	21.63	25.43	17.25	21.65	25.34
	600	7.83	8.33	8.83	7.85	8.35	8.83	10.72	14.22	20.12	10.52	14.25	20.15
V2 (Local Variety)	No SI	3.4	5.5	6.65	3.40	5.55	6.60	4.88	7.88	8.88	4.85	7.88	8.80
	200	7.2	7.88	8.77	7.02	7.85	8.71	13.25	18.60	19.06	13.15	18.50	19.16
	400	10..2	11.67	11.85	10.1.2	11.57	11.85	14.35	23.30	23.50	14.31	23.40	23.40
	600	6.80	8.33	8.85	6.82	8.30	8.82	13.13	17.32	19.08	13.15	17.31	19.18
FLSD (0.05)		2.33	1.59	1.28	2.82	1.91	1.08	2.20	2.51	7.93	3.08	2.46	2.86
F-pr		0.89	0.03	0.16	0.05	0.89	0.16	<0.001	<0.001	0.92	<0.01	<0.001	0.06

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation

Table 6: Main Effects of Variety and Supplementary Irrigation Rate on Number of Branches and Number of stems of Potato at Kuru, Jos

	Number of Branches						Number of Stems					
	2017			2018			2017			2018		
	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP	6WAP	8WAP	10WAP
Variety												
V1 (Daimat)	2.96	3.25	3.89	2.76	3.15	3.79	3.00	3.32	3.88	3.01	3.22	3.78
V2 (Local Variety)	2.95	3.42	3.69	2.85	3.12	3.69	3.08	3.23	3.71	3.08	3.13	3.71
FLSD (0.05)	0.83	0.46	0.82	0.82	1.82	1.24	0.16	0.16	0.57	0.36	0.36	0.9
F-pr	0.39	0.82	0.44	1	0.56	0.47	0.23	0.23	1	0.42	0.42	0.18
Irrigation Rate (mm)												
No SI	2.35	2.55	2.86	2.25	2.55	2.86	2.91	3.05	3.56	2.82	3.05	3.16
200	2.92	3.18	3.30	2.80	3.28	3.30	3.12	3.21	3.67	3.15	3.19	3.47
400	3.45	3.86	3.91	3.45	3.76	3.91	3.20	3.33	3.41	3.20	3.23	3.61
600	3.86	3.90	4.01	3.16	3.30	3.41	3.44	3.54	3.73	3.14	3.18	3.23
FLSD (0.05)	0.35	0.36	0.38	0.4	0.35	0.38	0.33	0.33	0.76	0.32	0.32	0.35
F-pr	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VXW	0.84	0.57	NS	0.67	1.48	NS	0.82	0.42	NS	0.44	0.44	0.69

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation

Table 7: Interaction Effects of Variety x Supplementary Irrigation Rate on Number of branches and Number of stems of Potato at Kuru, Jos

		Number of Branches						Number of Stems						Stem girth (cm)					
		2017			2018			2017			2018			2017			2018		
Variety	Irrigation Rate (mm)	6 WAP	8 WAP	10 WAP	6 WAP	8 WAP	10 WAP	6 WAP	8 WAP	10 WAP	6 WAP	8 WAP	10 WAP	6 WAP	8 WAP	10 WAP	6 WAP	8 WAP	10 WAP
V1 (Daimat)	No SI	2	2.33	2.67	2.00	2.33	2.67	2.00	2.33	2.67	2.00	3.00	3.00						
	200	2.67	2.83	3.33	2.67	2.83	3.33	2.67	2.83	3.33	2.00	3.00	3.00	3.38	4.38	5.72			
	400	3.00	3.33	3.67	3.00	3.33	3.67	3.00	3.33	3.67	2.67	3.67	3.67	4.02	4.62	6.02	4.02	4.85	6.48
	600	2.33	3.33	3.33	2.33	3.33	3.33	2.33	3.33	3.33	1.83	2.33	2.33	5.85	3.15	4.40	2.38	3.15	4.40
V2 (Local Variety)	No SI	1.67	2.00	2.17	1.67	2.17	2.17	1.67	2.17	2.17	2.17	3.00	3.00	1.30	1.63	5.75	1.63	1.63	2.30
	200	2.33	3.00	3.00	2.33	3.00	3.00	2.33	3.00	3.00	2.67	3.00	3.00	3.55	7.77	6.22	3.22	4.77	6.22
	400	3.00	4.00	4.00	3.00	4.00	4.00	3.00	4.00	4.00	3.00	3.33	3.33	4.58	5.48	7.25	4.58	5.48	7.25
	600	2.00	2.67	2.67	2.00	2.67	2.67	2.00	2.67	2.67	2.33	3.00	3.00	2.22	3.72	4.85	2.22	3.72	4.85
FLSD (0.05)		0.84	0.57	0.83	0.67	1.48	0.94	0.67	1.48	0.94	0.44	0.44	0.69	3.69	3.55	3.07	0.57	0.66	0.66
F-pr		0.04	0.005	0.75	0.015	0.04	0.75	0.015	0.04	0.75	0.03	0.03	0.50	0.98	0.32	0.15	0.06	<0.001	<0.001

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation.

Table 8: Main Effects of Variety and Supplementary Irrigation Rate on Number of tubers/plant, Number of Seed tubers/plant and Number of Ware tubers/plant of Potato at Kuru, Jos

	Number of tubers/plant		Number of seed tubers/plant		Number of ware tubers/plant	
	2017	**2018**	**2017**	**2018**	**2017**	**2018**
Variety						
V1 (Daimat)	3.46	4.04	2.33	2.67	1.08	1.21
V2 (Local Variety)	3.29	3.26	1.88	2.17	1.42	1.46
FLSD (0.05)	0.61	0.18	0.59	1.35	0.38	1.12
F-pr	0.49	0.01	0.10	0.25	0.70	0.43
Irrigation Rate(mm)						
No SI	1.17	1.33	1.08	1.25	0.00	0
200	3.33	4.00	2.08	2.5	1.25	1.5
400	5.00	5.58	2.67	3.25	2.33	2.25
600	4.00	4.42	2.58	2.67	1.42	1.58
FLSD (0.05)	0.54	0.64	0.53	9.64	0.52	0.56
F-pr	<0.001	< 0.001	<0.001	< 0.001	<0.001	< 0.001
VXW	NS	1.79	NS	NS	NS	NS

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation

Table 9: Interaction Effects on Variety x Supplementary Irrigation Rate on Number of tubers/plant, Number of Seed tubers/plant and Number of Ware tubers/plant of Potato at Kuru, Jos

Variety	Irrigation Rate (mm)	Number of tubers/plant		Number of seed tubers/plant		Number of ware tubers/plant	
		2017	2018	2017	2018	2017	2018
V1 (Daimat)	No SI	1.33	1.5	1.17	1.33	0	0
	200	3.33	4.17	2.5	3	0.83	1.17
	400	5.17	6	2.83	3.5	2.33	2.33
	600	4.00	4.5	2.83	2.83	1.67	1.33
V2 (local variety)	No SI	1.00	1.17	1.8	1.17	0	0
	200	3.33	3.83	1.67	2	1.67	1.83
	400	4.83	5.17	2.5	3	2.33	2.17
	600	4.00	4.33	2.33	2.5	1.67	1.83
FLSD (0.05)		0.81	0.79	0.78	0.10	0.69	0.93
F-pr		0.85	<0.001	0.61	0.58	0.28	0.38

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation

Table 10: Main Effects of Variety and Supplementary Irrigation Rate on weight of Seed tubers/plant, weight of Ware tubers/plant and weight of tubers of Potato at Kuru, Jos

	Weight of seed tubers plant (kg)		Weight of ware tubers/plant (kg)		Weight of tubers (ton/ha)	
	2017	**2018**	**2017**	**2018**	**2017**	**2018**
Variety						
V1 (Daimat)	0.12	0.16	0.13	0.17	8.99	9.32
V2 (Local Variety)	0.09	0.2	0.12	0.13	6.84	7.12
FLSD (0.05)	0.05	0.88	0.016	0.12	1.31	2.61
F-pr	0.15	0.68	0.06	0.28	0.01	0.06
Irrigation Rate (mm)						
No SI	0.05	0.06	0	0	1.49	1.46
200	0.11	0.49	0.28	0.17	7.17.	7.08
400	0.13	0.17	0.26	0.14	14.09	13.57
600	0.13	0.13	0.15	0.12	10.16	9.50
FLSD (0.05)	0.04	0.5	0.07	0.07	1.82	1.95
F-pr	< 0.001	0.33	< 0.001	< 0.001	< 0.001	< 0.000
VXW	N S	NS	N S	NS	N S	NS

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability value, SI = Supplementary Irrigation

Table 11: Interaction Effects of Variety x Supplementary Irrigation Rate on weight of Seed tubers/plant, weight of Ware tubers/plant and weight of tubers of Potato at Kuru, Jos

Variety	**Irrigation Rate (mm)**	**Weight of seed per tuber (kg)**		**Weight of ware tubers/plant (kg)**		**Weight of tubers (ton/ha)**	
		2017	**2018**	**2017**	**2018**	**2017**	**2018**
V1 (Daimat)	No SI	0.07	0.09	0.00	0.001	2.27	20.28
	200	0.13	0.23	0.1	0.16	7.77	7.95
	400	0.15	0.19	0.6	0.33	15.3	16.01
	600	0.14	0.15	0.34	1.2	10.6	11.05
D2 (Local Variety)	No SI	0.02	0.02	0.00	0.00	0.72	6.64
	200	0.09	0.74	0.11	0.12	6.38	6.39
	400	0.12	0.15	0.22	0.26	11.83	12.16
	600	0.12	0.12	0.14	0.15	8.44	9.27
FLSD (0.05)		0.06	0.78	0.09	0.11	2.41	2.72
F-pr		0.77	0.59	0.26	0.76	0.63	0.73

WAP = Weeks after planting, FLSD (0.05) = Fisher's Least Significant Difference at 5 % level of probability, Ns = Not significant, F-pr = Probability
value, SI = Supplementary Irrigation

IV. DISCUSSION

Temperature of the study area makes the environment suitable for the production of potato. [14] Reported that potatoes require a well-drained rich loamy soil that is rich in humus and temperature range of 34 – 40 ^{0}C. The annual rainfall is far below the annual rainfall required for potato production. [15] had put the annual rainfall requirement for potato production at 1,400 mm. The high relative humidity between the months of May – September could favour the activities of potato blight diseases. This could pose a serious challenge to potato growers in the area [6].

The findings in this study agreed with the report of [16] who stated that potato growth appeared to be better with 450 mm of irrigation at the vegetative growth stage and also increase the percentage of large tubers and the sum of large and medium tubers.

The results implied that SI water of 400 mm is adequate for the production of both improved (Daimat) and local variety of potato.

This finding agrees with the findings of [17] who reported that in- vitro and post experiments have shown that water stress had significant effects on growth and physiological characteristic of potato. Similarly, [28] posited that under increasing soil moisture stress, photosynthesis and relative transpiration rate decrease faster in potatoes compared to other crops. [19] further emphasized that if the water stress is prolonged, plant will be stunted. [20] said that, compared with many other crop plants, potato close their stomata at relatively low soil moisture deficits. These authors further revealed that when the rate of evaporative loses from soil is high, drought stress will develop. At this stage, they said the crop will decrease expansion of new leaves, slow down photosynthesis and growth, thus decreasing water usage and conserving water for their future use. Essentially, the crop begins to shift from production mode to survival mode. The deceasing photosynthetic rate means less crop growth and yield.

Findings in this study showed that luxury consumption of water may lead to potato expending so much energy on vegetative production at the expense of reproductive production. This explain why 600 mm levels of SI performed better in terms of number of leaves, leaf area expansion and plant heights than the 400 mm level of SI which performed better in terms of yield and yield parameters. Potato is planted on a raised bed and it also has shallow roots, it requires sufficient water through supplementary irrigation at the time of dry spell for proper root initiation and tuber bulking. This explains why the yield was lower in No SI treatments compared to 400 mm level of SI rate treatments.

The improved variety of potato (daimat) had more number of tubers per plant than the local variety in 2018 planting season.

SI had high significant ($p < 0.05$) effect on number of tubers , number of seed tubers and number of ware tubers .400 mm SI treatments gave more number of the characters tested while the least were observed under no SI condition. The findings of this research agreed with the report of [16] that SI at the vegetative growth stage increased the percent of large tubers and the sum of large and medium tubers of potato compared to non-irrigated treatments.

The results showed that both varieties (Daimat and local variety) gave more number of leaves and more leave area when combined with 400 mm SI relative to combination with No SI. This implied that SI of 400 mm is suitable for the production of irrespective of the variety involved. It also implied that combining variety above or below 400 mm SI may be counterproductive.

400 mm SI appeared to be the optimum SI water needed for potato production in the area it gave more number of stems of both Daimat and local variety. This findings agrees with the findings of [16] who reported that potato growth appeared to be better with 450 mm of water at vegetative growth stage.

The findings of this research agreed with the report of [16] that SI at the vegetative growth stage increased the percent of large tubers and the sum of large and medium tubers of potato compared to non-irrigated treatments.

The outcome of this study agrees with the report of [21] who posited that drought incidence remains one of the major causes of reduction in yield of crops especially in arid and semi-arid areas there by resulting in poverty, food shortage and reduction in the standard of living of the rural farmers. [22] had also pointed out that root and tuber crops are affected by drought mostly at tuber initiation and bulking stages. The results also corroborated the findings of [23] who opined that non-irrigated treatments of potato produced 500 % lower yield than irrigated treatments. Similarly, [24] found out that yield losses are caused by deficit irrigation at different growth periods of potato.

The study showed that variety has no impact on yield during the 2017 cropping season. This trend was maintained during the 2018 season. This indicates that the local variety compete favourably with the improved variety as long as production factors are favourable.

It appears that the vegetative growth of potato showed interactive effects with SI . However for the yield and yield parameters, the interaction showed no significant effect. This may be because as the crop ages the demand for water reduces [6].

V. CONCLUSION

From the study it can be concluded that:

i. Supplementary irrigation for the production of potato in the study area especially during the period of erratic rainfall be practiced.
ii. Monitoring of soil moisture for potato production in the study is important.
iii. Supplementary irrigation rate of 400 mm should be adopted in the study area.

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