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The Influence of Deficit Irrigation and Poultry Droppings on the Performance of Irrigated Pepper in Semi-Arid Region

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Abstract: *This study investigated the combined influence of deficit irrigation and poultry litter composting on the performance of irrigated pepper (Capsicum annum L.). The field experiment was conducted during the year 2024 dry season farming in Maiduguri. The Borno state capital in semi-arid region of northern Sahel savannah of Nigeria. The experiment was laid in a randomized complete block design (RCBD) with three replications using Basin irrigation system. Different irrigation water requirement level was imposed in the treatment, 50%, 75% and 100%ETc (crop evapotranspiration) and that of poultry litter are 1kg and 1.5kg/plot. The result obtained indicate that the reduction in ETc at 50% have not significant, but at 75% ETc and 100%ETc the produce yielded positive and there is no significance difference in both the growth and yield at that level. The highest yield obtained was at treatment T8 (100%ETc and 1.5kg of poultry litter per plot) WITH 23.71 kg/m^2 followed by T7(100%ETc and 1kg of poultry litter per plot) and T5(75%ETc and 1.5kg of poultry litter per plot) with 18.63 kg/m^2 and 17.66 kg/m^2 respectively. The study thus revels that basin irrigation at 75% ETc with 1.5kg, PL, has an explicit role in increasing the yield of bell pepper (capsicum annum L.) and reduction in water wastage at about 25%. The tallest height was observed at T8 (100%ETc+ 1.5kg of PL) with mean values of 20.433cm, 20.88cm, 38.167cm and 44.267cm The highest yield was recorded at T8(100%ETc+1.5kg, PL) with 23.71kg/m^2 followed by T7(100%ETc+1kg, PL) and T5(75%ETc+1.5kg, PL) with 18.63kg/m^2 and 17.66kg/m^2, the study concludes that the combination of deficit irrigation and poultry droppings improved growth of bell pepper (capsicum annum L.), leading to maximization of yield.*

Keywords: *Water Stress; Bell Pepper; Poultry Litter; Growth Parameter.*

INTRODUCTION

Innovations are needed to increase production and reduce cost of fertilizing crop have revived the use of organic fertilizer worldwide. Bell pepper (Capsicum annum L.) are good source of vitamin A, C, and fibre. They also possess antioxidant properties, which may help to protect against cardiovascular diseases and some cancers (Alissa Palladino, 2023). is one the most widespread vegetables in the world, being part of the top ten cultivated in the world (Adelsattar *et.al.* 2020).

Irrigation water deficit (IWD) is a practice of supplying water to crops at rates lower than the actual crop water requirement for a predetermined period and/or degree of

severity. The deficit is created either by supplying a pre-calculated amount of water lower than the calculated crop water requirement or by extending the irrigation interval. In a way, it is a deliberate means of subjecting crops to some degree of moisture stress. (Dibal *et al*.,2010). The influence of moisture stress on crop yield is a complex factor depending on duration, intensity, frequency and timing of stress, genotype and environmental factors (Mudiare and Bungwon, 2002). But shortage of water is the most important limitations for crop production, especially in the arid and semi-arid regions of the world.

Poultry litter is an organic waste material comprising of urine and faces of poultry birds e.g., chicken. The manure is obtained by removing and cleaning the beddings in the poultry houses along with faces. (sheikh, 2013). Annually 20,000 tons of poultry manure is generated globally for every 100,000 birds with an average weight of 1.81kg per bird (Chaistain *et al*.,1999). Poultry manure contains almost all 13 essential nutrients needed by plants with approximately 65.5% of nitrogen, 83.5% potassium, and 68.5% of phosphorus. It also contains calcium, magnesium, copper, iron, manganese, sulphur, boron, molybdenum, cobalt, and zinc. Which are mostly not found in inorganic fertilizer (Singh, 2020).

In developing countries like Nigeria, with a high population growth rate, that improved technologies including rational use of fertilizers must be employed to meet the food requirements of the people (Beyenesh and Nigussie, 2018). Semi-arid zone of northern Sahel savannah, where rain-fed farming is usually practised which would not ensure the availability of fresh pepper all year round to satisfy the demand of the populace. This could be as result, of farmers' lack the skills of in irrigation and irrigation scheduling (Dibal *et al*, 2010). And those that are using irrigation, usually over irrigate or under irrigate which would adversely reduce the expected yield to harvest. Therefore; this research aimed to investigate irrigation water deficit and composting poultry manure into the soil as an alternative to inorganic fertilizer in order to reduce cost, reduce the effect of the synthetic materials on the soil structure and determine how to use the limited water available judiciously so as to ensure a high return in pepper production.

MATERIALS AND METHOD

Experimental site:

The experiment was carried out from February 2024 to June 2024, at Maiduguri, Borno state, in a semi-arid region of North-eastern Nigeria. The area lies between 11.5^0N and 13.5^0E with a mean elevation of 345m above sea level (Dibal *et al*., 2009). The soil type of the area is sandy loam (USDA, 1962). The climate of the environment is semi-arid and is characterized by straight slopes varying in gradient between 0.5 to 5%, wide spreadsheet erosion, and in many other places, it is deeply dissected by 10 to 50m wide steep-sided gullies. The area has a low to moderate nutrient and water retention capacity but is highly erodible and susceptible to drought. (Dibal *et al*., 2013). Rainfall data was recorded during the period of the study using FAO CROPWAT and CLIMWAT software (FAO 2009).

Climate:

Climatic data from CLIMWAT 2.0 software; daily temperature, relative humidity, wind speed, sunshine hours and solar radiation was obtained to calculate the monthly reference crop evapotranspiration (ET_o) in CROPWAT 8.0 software. Crop

evapotranspiration (ET_c) was then calculated, recommended crop coefficient (kc values) of bell pepper was used. (Allen *et.al.* 1998). Presented in Table 2.

Experimental Design and Treatments:

The experimental factors were deficit irrigation and poultry manure mulching. The deficit irrigation was at three (3) levels, 50%ETc, 75%ETc, and 100 % ETc while poultry liter PL was also at three levels, 1kg, 1.5kg, and control. These factors were combined and replicated three times to form a total of 27 treatments.

The treatment was laid in a Randomized Complete Block Design (RCBD). Three soil samples were taken from the experimental site from a depth, 0 – 30cm, soil samples were analyzed for pH, soil organic matter, nitrogen, phosphorus, potassium, and magnesium content. Textural classification of the soil sample was also determined using sieve analysis and classifies with USDA textural triangle. The experimental field was harrowed manually, each plots and replica was marked out in accordance with the design. Each plots were measured 1×1m. There was a total of nine plots in each replicate, there also inter-plot and inter-replication borders to facilitate operation. A total of 0.0027ha, was used for the experiment. Seedlings of pepper were prepared at the suitable site at 10m beside the experimental field, on which seedlings were raised. After the nursery stage, 48 days after germination, the seedlings were transplanted to the experimental plots in the late evening hour to control the temperature effect. The seedlings were 50cm apart along, two seedlings were used per plot of $1m^2$, making 54 stand per whole experiment plots. Weeding was carried out manually at every two weeks after transplanting. For each of the treatments, irrigation water was applied in measured quantities directly to the plots under basin irrigation based on the crop water requirement of pepper with an effective root zone depth of 0.31m. (Ertek *et, al*,.2007).

Table 1: Experimental Design

Replicate 1	Tl	T2	T3	T4	T5	T6	T7	T8	T9
Replicate 2	T4	T5	T6	T7	T8	T9	T1	T2	T3
Replicate 3	T7	T8	T9	T1	T2	T3	T4	T5	T6

Arrangement of experimental design.

Table 2. Steps to estimate the volume of water based on crop water requirement

Steps	Values
Crop evapotranspiration ETc = ET_O × Kc (mm/d)	ETc February = 7.08mm/day ETc March = 9.13mm/day ETc April = 9.41mm/day ETc May = 4.51mm/day
Area of plot A= L×B(mm^2)	1,000000mm^2
Volume of water needed	February = 7.08mm/d ×1,000000mm^2 = 7,080,000mm^3= 7080ml = 7.08ltr. March = 9.13mm/d ×1,000000mm^2 = 9,130,000mm^3 = 9130ml = 9.13ltr. April = 9.41mm/d ×1,000000mm^2 = 9,410,000mm^3 = 9410ml = 9.41ltr. May = 4.51mm/d × 1,000000mm^2 = 4,510,000mm^3 = 4510ml = 4.51ltr.

RESULTS AND DISCUSSION

Physio- Chemical Properties of Soil

Table 3 below represent the result of soil analysis. The textural classification of the experimental site was determined, with 54.4 %sand, 23.7%silt, and 21.8% clay, which translate the soil, sandy loam using USDA soil textural triangle. The soil pH was recorded 5.99, of which it is slightly acidic below the recommended value of 6.5 – 7.0 (Marissa schuh, 2022). the mean value of soil organic matter was 2.6%. other chemical properties recorded was Nitrogen, phosphorus, potassium and magnesium with mean values of 2.85mg/kg, 9.84mg/kg, 1.0mg/kg and 2.63mg/kg respectively. The nutrient value of the experimental site, was best for bell pepper production (Yahaya *et., al*., 2012).

Table 3. Physio-chemical properties of soil

Soil characteristics	Values
Ph	5.99
SOM	2.60
N (mg/kg)	2.85
P (mg/kg)	9.84
K (mg/kg)	1.0
Mg (mg/kg)	2.63
% Sand	54.4
% Silt	23.7
% Clay	21.8
Class	SL

SOM – Soil organic matter. **SL – sandy loam**

The influence of deficit irrigation and poultry droppings on the growth parameters of bell pepper (capsicum annum L.)

Tables 4,5, and 6, below present the growth and yield parameters of bell pepper during the experimental study. The parameters determined include; plant height, stem diameter, number of leaves per plant, number of pods, weight per pod and yield of bell pepper at, 20, 40, 60 and 80 days after transplanting (DAT).

Plant Height

Crop water requirement (ETc) at 50%, 75% and 100% in combination with poultry litter (PL) at 1kg, 1.5kg and 0kg was used at the growing stage of bell pepper. Statistically, there is a high significant difference among the treatments at P< 0.05. the tallest height was observed at T8 (100%ETc+ 1.5kg of PL) with a mean value of 20.433cm, 20.88cm, 38.167cm and 44.267cm, at 20DAT, 40DAT, 60DAT and 80DAT respectively, followed by T7 (100% ETc + 1kg of PL) with 18.600cm and 28.233cm at 20DAT and 40DAT and T5(75% ETc + 1.5kg of PL) with 37.500cm and 42.267cm, at 60DAT and 80DAT in that order.

The least mean value was recorded at T3 (50% ETc, control) with 14.033cm, 16.833cm, 19.367 cm, and 19.733cm at 20DAT, 40DAT 60DAT respectively.

Stem Diameter

The stem diameter of the bell pepper was recorded as shown in Table 5. Statistically, there was high significant difference among the treatments at P< 0.05. at 20DAT the highest diameter was recorded at T8 (100%ETc+1.5kg PL) with 0.3400cm, with the least diameter at T3 (50%ETc, control). at 40DAT, the highest stem diameter was observed at T5 (75%ETc + 1.5kg PL), with 0.633cm, with the least at T3 (5%ETc control) with 0.2700cm. also at 60DAT, there was no significant difference between, T5 (75%ETc+1.5kg, PL), T7(100%ETc+1kg, PL) and T8(100%ETc+1.5kg, PL) with 0.745cm, 0.7533cm, and 0.7500cm, with the least diameter recorded in T3(50%ETc, control) with 0.373cm. at their final growing stage, the highest yield was recorded in T8(100%ETc+1.5kg, PL) with 0.9567cm with least at T3(50%ETc control).

Number of Leaves Per Plant

From the result of influence of deficit irrigation and poultry droppings on number of leaves shown in table 5, below, statistics revealed, there was significant difference at P< 0.05, on the number of leaves of bell pepper. The highest number of leaves per plant at 20DAT, 40DAT,60DAT and 80DAT was recorded at T5(75%ETc+1.5kg, PL) with, 22.68cm, 60.33cm,104.00cm and 147.3cm, with the least number of leaves recorded T3(50%ETc, control), with 33.00cm, 47.67cm, and 56.33cm. from the result it was found, there with no significant difference in T5, and T7 at 20DAT and T7 and T7 and T8 at 80DAT respectively.

Table 4. Present the influence of deficit irrigation and poultry droppings on plant height (cm) of bell pepper

Treatment	20DAT	40DAT	60DAT	80DAT
T1	16.567^{e}	21.133^{c}	25.767^{c}	30.167^{e}
T2	17.100^{c-e}	21.600^{c}	26.800^{c}	31.800^{d}
T3	14.033^{f}	16.833^{d}	19.367^{e}	19.733^{h}
T4	17.900^{b-d}	25.467^{b}	36.633^{b}	39.800^{c}
T5	18.000^{bc}	26.067^{b}	37.500^{ab}	42.267^{b}
T6	16.533^{e}	19.467^{cd}	23.267^{d}	23.500^{g}
T7	18.600^{b}	28.233^{ab}	37.100^{ab}	41.800^{b}
T8	20.433^{a}	30.833^{a}	38.167^{e}	44.267^{a}
T9	16.967^{de}	20.833^{c}	24.300^{D}	25.333^{f}
LSD	**	**	**	**
CV	3.36	7.24	2.68	2.68

** *Represent high significance at P<0.05, CV represent coefficient of variance, LSD represents a least significant difference.*

Table 5. Present the influence of deficit irrigation and poultry droppings on stem diameter (cm) of bell pepper.

Treatment	20DAT	40DAT	60DAT	80DAT
T1	0.2100^{d}	0.4033^{cd}	0.5133^{cd}	0.6100^{cd}
T2	0.2467^{c}	0.4633^{bc}	0.5833^{bc}	0.6367^{cd}
T3	0.1933^{d}	0.2700^{d}	0.3733^{e}	0.4167^{e}
T4	0.2467^{c}	0.4733^{bc}	0.6500^{ab}	0.7633^{bc}
T5	0.2967^{b}	0.6333^{a}	0.7433^{a}	0.8567^{ab}
T6	0.2033 ^{d}	0.3100^{d}	0.3900^{de}	0.4933^{de}
T7	0.3100 ^{b}	0.5867^{ab}	0.7533^{a}	0.8467^{ab}
T8	0.3400^{a}	0.5667^{ab}	0.7500^{a}	0.9567^{a}
T9	0.2100^{d}	0.5100^{a-c}	0.5733^{bc}	0.6300^{cd}
LSD	**	**	**	**
CV	5.43	16.82	12.83	12.91

**** Represent high significance at P<0.05, CV represents the coefficient of variance, and LSD represents a least significant difference.**

Table 6. Present the influence of deficit irrigation and poultry droppings on the number of leaves per plant.

Treatment	20DAT	40DAT	60DAT	80DAT
T1	16.000^{d}	35.000^{d}	61.00^{d}	83.00^{cd}
T2	18.000^{cd}	35.000^{d}	64.00^{cd}	84.67^{cd}
T3	18.667^{b-d}	33.000^{d}	47.67^{d}	56.33^{e}
T4	19.333^{a-d}	41.000^{cd}	80.33^{bc}	102.00^{bc}
T5	22.667^{a}	49.667^{bc}	96.00^{ab}	127.00^{ab}
T6	21.000^{a-c}	40.333^{cd}	55.00^{d}	75.33^{de}
T7	22.000^{ab}	53.667^{ab}	94.67^{ab}	131.67^{a}
T8	22.667^{a}	60.333^{a}	104.00^{a}	147.33^{a}
T9	19.667^{a-d}	38.667^{d}	52.00^{d}	80.00^{c-e}
LSD	**	**	**	**
CV	11.3	13.1	13.49	13.49

*** Represent high significance at P<0.05, CV represents the coefficient of variance, and LSD represents a least significant difference.*

Number of pods per plant

Table 7. below presents a number of pods per plant under the influence of deficit irrigation and poultry droppings on the performance of bell peppers. Statistics revealed, there is significant difference between the treatment at P< 0.05. the number of pot per plant was recorded high at T8 (100%ETc+1.5kg, PL) with, 9.33, followed by T5(75%ETc+1.5kg, PL) with 8.00. the plant with least pod was recorded at T3(50ETc, control) with 1.00, followed by T1 (50%ETc+1kg, PL) with 1.66, respectively.

Weight per pod

The weight per pot was recorded higher at T9(100%ETc + control, PL) with 93.97g, and T7(75%ETc+1.5kg, PL) with 90.06g. statistically, there is no significant difference at the treatment. The second highest weight of pod was recorded at T5(75%ETc+1kg, PL) with 86.10g, with the least weight recorded at T1(50%ETc+1kg, PL), T3(50%ETc, control), T6(75%ETc, control), and T8(100%ETc+1.5kg, PL) respectively.

Yield

The influence of deficit irrigation and poultry litter on the yield performance of bell pepper presented in table 6. There was high significance difference at P< 0.05. the yield of bell pepper was influenced by deficit level and the level of poultry litter used. The highest yield was recorded at T8(100%ETc+1.5kg, PL) with 23.71kg/m^2 followed by T7(100%ETc+1kg, PL) and T5(75%ETc+1.5kg, PL) with 18.63kg/m^2 and 17.66kg/m^2.respectively.The least yield was recorded at T3(50%ETc, control) with 1.12kg/$m^{2.}$ Yield is the most important component of plant performance under a set of growing condition as any physiological and agronomic parameters at a given stage of growth would be use when its effect is reflected on the yield of the crop. (Adeoye *et al,* 2014). The effect of water stress and organic matter level has led to reduction in agronomic parameters of bell pepper (capsicum annum L.). it can be observed from the study T8(100%ETc+1.5kg, PL), T7(100ETc+1kg, PL), and T5(75%ETc+1.5kg, PL) thrived than other treatment. This finding is in conformity with (Abdelsattar *et al*.2020) who stated that pepper plant cultivated under deficit irrigation reduced fruit biomass and indicators of plant water status. Applying water deficits during the vegetative growth, fruit setting stage had minimal effect on the marketable yield but with minimal water savings. Maximizing soil organic matter level is the key aspect of any organic production system. (Musa *et al*. 2023).

Table 7: Present the influence of deficit irrigation and poultry droppings on the yield and yield parameters of bell pepper.

Treatment	Mean Number of fruit per pot	Mean weight per fruit (g)	Yield kg/m^2
T1	1.6667^{fg}	43.467^{c}	1.939^{fg}
T2	2.6667^{ef}	46.533^{c}	2.957^{ef}
T3	1.0000^{g}	41.267^{c}	1.116^{g}
T4	6.0000^{c}	80.267^{b}	1.281^{c}
T5	8.0000^{ab}	86.100^{ab}	17.666^{b}
T6	3.6667^{de}	43.000^{c}	4.269^{e}
T7	7.6667^{b}	90.067^{a}	18.638^{b}
T8	9.3333^{a}	49.000^{c}	23.71^{a}
T9	4.3333^{d}	93.967^{a}	6.528^{d}
LSD	**	**	**
CV	15.81	9.44	9.78

*** Represent high significance at P<0.05, CV represents the coefficient of variance, and LSD represents the least significant difference.*

CONCLUSION

Based on the result recorded in this study, the combination of deficit irrigation and poultry droppings improved growth of bell pepper (capsicum annum L.), leading to maximization of yield. On average, T8 produces the highest yield followed by T7 and T5. The lowest yield was recorded in T3 and T1. Therefore, the study has concluded that a 25% reduction in crop water requirement (ETc) plus 1.5kg/m^2 of poultry litter is best for bell pepper production under water stress conditions in the semi-arid region of northern Sahel savannah, Maiduguri, Borno state.

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REFERENCES

Allen R.G. Pereiri L.S., Raes D., and Smith M. (1998). Crop evapotranspiration Guidelines for computing crop water requirement- FAO irrigation and Drainage pepper 56. Rome. FAO of the UN 1-13

Adeoye P. A, Adesiji R.A., Oloruntade A.J. and Njemanze C.F., (2014). Effect of irrigation interval on Growth and yield of bell pepper (capsicum annum L.) in a tropical semi-arid region: American journal of experimental agriculture 4(5): 515-524, 2014.

Abdelkhalik A, Pascual B, Najera I, Domene M.A., Baixaauli C., Pascual-seva N. (2020). Effect of deficit irrigation on the yield and irrigation water use efficiency of bell pepper (capsicum annum L.) under Mediterranean condition. Springer- verlag GMBH Germany.

Dimple, S.R. Bhakar, S.S.Lakhawat and M.kothori, (2017). Effect of deficit irrigation and plastic and plastic mulch on yield and water use efficiency of drip

irrigated pepper: International journal of current microbiology and applied science ISSN: 2319-7706 Volume 6. Number 12(2017). pp.2878- 2889.

FAO (Food and Agriculture Organization) (1989). Guidelines for designing and evaluating surface irrigation system: irrigation and drainage paper NO.45.Rome, Italy: FAO.

Jibrin M.Dibal, Baba Gana Umara, Habib Alkali and A. Abdullahi., (2010). Response of cowpea (vigna unguilata L.) to irrigation water deficit at different growth stages in semi-arid region. Continental journal of agricultural science 4:48-53,2010.

Michaell D. Dukes (2003). Effect of sensor- based high frequency irrigation onbell pepper yield and water use: preceding 2nd International conference on irrigation and drainage, phoenix, AZ May 12-15-2003.pp 665.674.

Mishra R.D., and M. Ahmed. (1990). Manual on irrigation agronomy. Oxford and IBH Publishing co. PVT.LTD. New Delhi, Bombay, Calcutta.

Owoeye Adetutu Oluwapelum, Opodokun Wasiu Olanrewaju and Olorunmaiye Kehinde Stephen, (2024). Influence of poultry manure on the performance of bell pepper (capsicum annum L.). Bulgerian journal of crop science, 61(1), 87-92.

Sam- Amoah L.K., Willie W.K.T., and Owusu – sekyere J.D (2000). Effect of deficit irrigation and chicken manure interaction on the growth and yield of okro in a pot experiment. Asian journal of agricultural research. 10(1):47-55.

Smith M. (1992). CROWAT, a computer program for irrigation planning and management. Irrigation and drainage paper 46, FAO. Rome, Italy.