PAPER • OPEN ACCESS

Yield and Nutrient Uptake by Sudangrass (*Sorghum Vulgare var. Sudanense*) as Influenced by Phosphorus and Zinc Application

To cite this article: Anhar M. Alshummary *et al* 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1262** 052053

Yield and Nutrient Uptake by Sudangrass (*Sorghum Vulgare var. Sudanense*) as Influenced by Phosphorus and Zinc Application

Anhar M. Alshummary[1], Lamiaa M. Al-Freeh[2] and Sundus A. Alabdulla[3]

[1,2]Department of Field Crops, College of Agriculture, University of Basrah, Basrah, Iraq.

[1]E-mail: anhar.jaaz@uobasrah.edu.iq
[2]E-mail: lamiaa.salman@uobasrah.edu.iq
[3]E-mail: sundus.mohammed@uobasrah.edu.iq

Abstract. The study was conducted at the Basrah University / Karmat Ali, Iraq during the fall season 2020, to investigate the effects of four rates of phosphorus,(P0 =0, P1=40,P2=80 and P4=120 kg P ha^{-1}) and spraying four concentrations of zinc (Zn0-control,Zn1= 25,Zn2=50,Zn=75mgL^{-1} on growth and forage yield of Sudangrass**.** The randomized complete block design (RCBD) was carried out in three replicates using a split plot experiment , zinc concentrations were put in the main plots while, rates of phosphorus in subplots. Application with P_{120} resulted to a significantly greater stem diameter (14.61mm) number of leaves (20.00 leaf plant^{-1}),leaf area (7420cm^2), number of branches (14.967 branch plant^{-1}) green and dry forage yield (29.25,12.69 t ha^{-1}).Foliar application of Zn_{75} resulted in greater plant height (251.2cm), stem diameter (14.21mm), number of leaves (19.42 leaf plant^{-1}),leaf area (6163cm^2) and number of branches (13.450 branch plant^{-1})**.** The combination of P× Zn had no significant effect on green and forage yield. Both P and Zn application had significant effect on N and P percentage of forage Sudangrass, on the other hand, no significant effect of their application on K percentage .

Keywords. Forage Sudangrass, Phosphorus, Zinc, Green forage, Dry forage.

1. Introduction

The agricultural sector has encountered a recent challenge in the form of water scarcity, which has compelled farmers to cultivate crops with low water requirements, particularly in semi-arid regions across the globe [1,2] ,Thus, the forage sorghum, which has many attractive qualities, has gained popularity as a summer feed option every year [3]. Various cultivars of forage sorghum have a diverse array of environmental tolerances, including resilience to high temperatures and drought conditions. These cultivars also demonstrate a high degree of water use efficiency and exhibit rapid regrowth after grazing or cutting [4]. Therefore, due to the impacts of global warming, there is a possibility that these crops will garner greater attention as a potential source of summer forage in the coming years. One of the kinds of forage sorghum is Sudan grass; nevertheless, it is important to note that Sudan grass exhibits distinct characteristics compared to forage sorghum. Specifically, Sudan grass demonstrates a higher propensity for branch production and possesses finer stems [5]. The Sudangrass exhibits a notable capacity for rapid post-harvest growth, distinguishing it from feed sorghum and rendering it more appropriate for pasture and straw production. The hybrids resulting from the crossbreeding of forage sorghum and Sudangrass are commonly referred to as haygrazers. These hybrids are obtained by mating the male plants of Sudangrass with the female plants of the forage sorghum crop. The user has provided a reference to support their statement.The hybrids exhibit a higher development potential compared to fodder sorghum, although their growth is comparatively lower than that of Sudan grass, owing to their capacity to generate a significant number of branches. In addition, Sudan grass has a comparatively lower biological yield when compared to the aforementioned crop [6].

The majority of arid and semi-arid soils worldwide, including the soil found in Iraq, exhibit distinctive features such as a substantial abundance of calcium ions and mineral carbonates, limited organic matter content, and elevated pH levels. These characteristics collectively contribute to a notable reduction in the availability of phosphorus. As a result, the plant demonstrates reduced efficiency in utilizing these nutrients[7]. The presence of phosphate fertilizers is crucial in order to attain optimal levels of readily absorbable phosphorus, as it directly influences growth and yield. To achieve optimal levels of forage production in an environmentally conscious manner, it is crucial to effectively manage primary, secondary, and micronutrients [8]. Incorporating phosphorus and zinc into sorghum cultivation may enhance the crop's capacity to provide forage. The production of quality and quantity of forage is directly influenced by the use of phosphorus fertilizer. Phosphorus is an essential constituent of nucleic acid and plays a vital role in many metabolic activities and cellular respiration. It actively engages in numerous enzymatic processes, encompassing carbon dioxide fixation, sugar metabolism, energy storage, and energy transfer. The appropriate utilization and agronomic management of phosphorus can contribute to the enhancement of per-hectare agricultural productivity [9-11]. The gradual application of phosphorus to Sorghum resulted in a significant increase in plant height, the number of leaves per plant, leaf area, and fodder yield [12]. Zinc is a crucial element that plays a vital role in glucose metabolism and is a constituent of various proteins, such as enzymes and transcription factors. The role it plays in these processes is of significant significance [13,14]. Additionally, zinc is necessary for the production of tryptophan, which is a source to auxin-indole-3-acetic acid [15].The purpose of this study is to assess how fertilization with phosphorus and zinc affects the forage yield of Sudan grass hybrid in south of Iraq.

2. Materials and Methods

The study was conducted at the Basrah University / Karmat Ali, Iraq (30° 57′ N lat.,47° 80′ long) during the fall season 2020, to investigate the effects of four rates of phosphorus,(P0 =0, P1=40,P2=80 and P4=120 kg P ha^{-1}) and spraying four concentrations of zinc (Zn0-control,Zn1= 25,Zn2=50,Zn=75mgL^{-1} on growth and forage yield of Sudangrass. Ladder was used to level the field after two plowings. Soil samples were collected from several locations in the experimental field at a depth of 0–30 cm, analyzed, that specific field's soil was silty loam, which had a pH of 7.50, a lower organic carbon content (%0.37), low available nitrogen (32.25 m kg^{-1}), medium levels of phosphorus (18.3 kg ha^{-1}) and potash (111.25 kg ha^{-1}). The randomized complete block design (RCBD) was carried out in three replicates using a split plot experiment , zinc concentrations were put in the main plots while, rates of phosphorus in subplots .The plot's area was 3 ×3m^2, with six rows spaced 50cm apart and 20cm between hills. On July 15th, Sudangrass hybrid seeds (6FSG 214 BMR) were planted. However, three equal doses of 200 kg N ha^{-1} of urea [**16**] nitrogen fertilizer were added, the first dose was added at the time of sowing, the second 21 days later, and the third dose 21 days after the second dose. At the time of sowing, four P levels were applied using triple superphosphate fertilizer (46% P_2O_5).Ten plants were randomly chosen from each plot before harvest in order to collect data on various growth characteristics,including plant height, the total number of tillers, the numbers of leaves per tiller, the area of the leaves, and the diameter of the stems. Green fodder yield was measured by cutting the crop 90 days after sowing, weighing the harvested fodder in kilograms per plot, and calculating the yield in ton per hectare.

2.1. Plant Analysis

Plant samples (leaves and stems), were cleaned with distilled water to get the impurities off then dried in the oven at 65 °C for 48 hours. For each sample, 0.2 g of dry plant powder was digested by adding a solution of 96% concentrated sulfuric acid H_2SO_4 and 4% acid perchloric ($HClO_4$) according to [17]N, P, and K concentrations were measured in the digest using [18] for Nitrogen, [19] for Phosphorus and Potassium, [20]. By using SPSS version 20, statistical analysis of the recorded data was performed. LSD test at 0.05 level of probability was used to compare means [21].

3. Results and Discussion

3.1. Growth Parameters

The findings show that the morphological characteristics were significantly affected by P rates and Zn concentration (Table 1). The results presented (Table 1) indicate the tallest plant height was found 247.6cm in treatment P_{40} kg ha^{-1} with comparison to the other three treatments, which were 234.7cm in treatment P_{80}, 230.3cm in treatment P_{120}, and 144.5 cm in treatment P_0 . Application with P_{120} resulted to a significantly greater stem diameter (14.61mm)number of leaves per plant. (20.00 leaf $plant^{-1}$)leaf area (7420cm^2) and number of branches (14.967branch $plant^{-1}$) as compared to rest of the treatments. With an increase in the level of phosphorus, vegetative growth of the plant is enhanced resulting in better growth, increase in growth characteristics was mostly caused by the role of phosphorus in promoting root growth, which accelerates up nutrient absorption in addition to its involvement in the synthesis of energy compounds, an increase in cell division, and elongation, all of which have an impact on growth characteristics[22] [23] [24]. These findings correspond with [25] [26] [27]. The stem diameter ,number of leaves , leaf area and number of branches were significantly affected by different foliar concentrations of zinc, application of Zn_{75} resulted in greater plant height (251.2cm), stem diameter (14.21mm) number of leaves (19.42 leaf $plant^{-1}$),leaf area (6163cm^2) and number of branches (13.450 branch plant-1) whereas, application of Zn_0 gave the lowest values. The main cause of the increase in growth parameters was a larger intake of zinc, which plays a role in metabolic activities within the plant and increases photosynthetic efficiency,it also participates in the production of the amino acid required for cell elongation [28] [29].The combination P and Zn (Table 1) improved plant height in Sudangrass, $P_{40}Zn_{50}$ gave 296.7cm, which was at par with $P_{40}Zn_{75}$ (292.3cm) ,while combination of P_{120} Zn_{75} gave the highest stem diameter (16.16mm) ,number of leaves (21.33 leaf $plant^{-1}$), leaf area (7007cm^2) and number of branches (18.267 branch $plant^{-1}$). This is due to the nutritional balance of these two nutrients made to activate hormones and increase photosynthetic efficiency, which enabled the plant develop more successfully.

Table 1. Effect of phosphors and zinc concentrations on some growth traits of Sudangrass.

Treatments		Plant height (cm)	Stem diameter (mm)	Number of leaves per plant	Leaf area (cm^2)	Number of branches per plant
Phosphorus ($kg\ ha^{-1}$)	P_0	144.52	12.33	14.08	3275	7.025
	P_{40}	6247.6	12.33	16.25	4516	10.358
	P_{80}	6234.7	12.92	17.58	6182	13.358
	P_{120}	230.32	14.61	20.00	7420	14.967
LSD ($P \leq 0.05$)		10.26	0.84	1.129	493.9	0.4036
Zinc ($mg\ L^{-1}$)	Zn_0	162.86	11.75	15.25	4414	8.925
	Zn_{25}	205.23	13.00	15.42	5301	11.125
	Zn_{50}	237.93	13.23	17.83	5515	12.208
	Zn_{75}	251.24	14.21	19.42	6163	13.450
LSD ($P \leq 0.05$)		9.43	0.54	1.297	614.4	0.3898
P_0Zn_0		140.11	11.00	12.33	2674	5.900
$P_{40}Zn_0$		152.72	11.33	12.67	2949	7.500
$P_{80}Zn_0$		172.4	12.33	17.67	5926	9.767
$P_{120}Zn_0$		186.2	12.33	18.33	6108	12.533
P_0Zn_{25}		141.31	12.33	12.00	2786	7.133
$P_{40}Zn_{25}$		248.91	11.67	13.67	3085	10.800

Treatments	Plant height (cm)	Stem diameter (mm)	Number of leaves per plant	Leaf area (cm^2)	Number of branches per plant
$P_{80}Zn_{25}$	217.70	13.67	15.67	6334	12.867
$P_{120}Zn_{25}$	213.00	14.33	20.33	8996	13.700
P_0Zn_{50}	146.01	12.33	16.00	3748	7.400
$P_{40}Zn_{50}$	296.70	12.00	17.33	5037	11.133
$P_{80}Zn_{50}$	263.62	13.00	17.00	5705	14.933
$P_{120}Zn_{50}$	245.37	15.60	21.00	7569	15.367
P_0Zn_{75}	150.63	13.67	16.00	3892	7.667
$P_{40}Zn_{75}$	292.31	14.33	21.33	6991	12.000
$P_{80}Zn_{75}$	285.3	12.67	20.00	6762	15.867
$P_{120}Zn_{75}$	276.71	16.16	21.33	7007	18.267
LSD ($P \leq 0.05$)	19.27	1.17	2.415	1132	0.7482

3.2. Forage Yield

Results (Table2) showed that adding P fertilizer rates significantly increased Sudangrass production of both green and dry forage showing a beneficial relationship with increasing levels of phosphorus application, However, no significant difference was observed among the foliar of Zn concentrations. The findings show that the highest green and dry forage yield was found 29.25 and 12.69 t ha^{-1}in treatment P_{120} which was at par with P_{80} , while the lowest value (22.58 and 10.37 t ha^{-1}) was observed at the control (P_0). It could be a result of the greater phosphorus levels having a positive impact on growth and development due to enhanced root proliferation, which would increase nutrient intake and enhance the photosynthetic efficiency of forage Sudangrass . The results agreed with those of [30] ,they found that increasing phosphorus fertilizer to74kg P_2O_5 ha^{-1} considerably increased the production of Sudangrass forage yield. As in case of Zn and P combinations were found non-significant with respect to green and forage yield.

3.3. Nutrient Concentrations

Both P and Zn application had significant effect on N and P percentage presented in Table (2), on the other hand, no significant effect of P and Zn application on K percentage of forage Sudangrass .As shown in Table 2 N percentage of forage Sudangrass increased with the application of different rates of phosphorus fertilizer over control. Application of phosphorus P_{120} recorded the highest N percentage than other treatments 2.918 %.The lowest N percentage(1.008%) was recorded in control.
The percentage of P increased with the various application rates of phosphorus over control .The higher percentage of P was found with the application of P_{120} (0.458%) and it was followed P_{80} (0.400%) and lowest was recorded in control (0.258%). increase in nutrient concentration is due to the positive role of phosphorus in root growth and increasing the rate of element absorption .Foliar application of Zn25 gave significantly maximum N percentage of forage Sudangrass (2.64%)at par with Zn50(2.573%),whereas, foliar treatment Zn_{75} was found to be effective in increasing the P %. (0.377%) at par with Zn $_{25}$ and Zn_{50}.

Table 2. Effect of phosphors and zinc concentrations on green weight dry weight and NPK percentage of Sudangrass.

Treatments		Green forage yield (t ha^{-1})	(Dry forage yield (t ha^{-1})	%N	%P	%K
	P_0	22.58	10.37	1.088	0.258	1.095
Phosphorus	P_{40}	24.32	11.43	2.305	0.306	1.133
(kg ha^{-1})	P_{80}	27.13	11.81	2.596	0.400	1.101
	P_{120}	29.25	12.69	2.918	0.458	1.112
LSD ($P \leq 0.05$)		2.63	1.334	0.054	0.049	N.S
	Z_0	23.44	10.10	1.428	10.33	1.121
Zinc	Z_{25}	25.09	11.09	2.644	30.35	1.111
(mg L^{-1})	Z_{50}	25.68	11.82	2.573	20.36	1.109
	Z_{75}	29.06	13.28	2.263	0.377	1.101
LSD ($P \leq 0.05$)		N.S	N.S	0.102	0.030	N.S

Treatments	Green forage yield (t ha^{-1})	(Dry forage yield (t ha^{-1})	%N	%P	%K
P_0Zn_0	15.02	7.26	1.040	0.220	1.127
$P_{40}Zn_0$	27.61	12.14	1.150	0.287	1.113
$P_{80}Zn_0$	27.91	10.57	1.090	0.387	1.140
$P_{120}Zn_0$	23.23	10.42	1.070	0.430	1.103
P_0Zn_{25}	22.51	11.79	1.130	0.280	1.120
$P_{40}Zn_{25}$	21.21	9.58	2.750	0.283	1.123
$P_{80}Zn_{25}$	28.55	12.08	2.830	0.400	1.090
$P_{120}Zn_{25}$	28.10	10.89	2.510	0.447	1.111
P_0Zn_{50}	23.58	10.81	1.660	0.283	1.117
$P_{40}Zn_{50}$	20.76	12.53	3.117	0.323	1.137
$P_{80}Zn_{50}$	29.57	11.93	3.153	0.387	1.060
$P_{120}Zn_{50}$	28.80	12.02	2.453	0.453	1.120
P_0Zn_{75}	29.16	11.61	1.880	0.250	1.017
$P_{40}Zn_{75}$	27.73	11.46	3.560	0.330	1.160
$P_{80}Zn_{75}$	22.48	12.65	3.217	0.427	1.113
$P_{120}Zn_{75}$	36.87	17.41	3.017	0.500	1.113
LSD ($P \leq 0.05$)	N.S	N.S	0.181	0.067	N.S

Conclusions

The green and dry forage yield of Sudangrass was found to be strongly affected by varying levels of phosphorus. The study's findings indicate that the application of 120 Kg P ha^{-1} resulted in significantly greater yields of green and dry forage. However, there was no significant difference seen in the foliar concentrations of Zn, both individually and in combination with P, on the yield of green and dry forage.

References

[1] Iqbal M. A., Iqbal, A, Akbar, N., Khan, H. Z. and Abbas, R. N. (2015). A study on feed stuffs role in enhancing the productivity of milch animals in Pakistan- Existing scenario and future prospect. Global Veterinaria 14(1), 23-33.

[2] AL-Taey, D. K. A., S. S. M. AL-Azawi, M. J. H. AL-Shareefi, and A. R. AL-Tawaha. (2018) Effect of saline water, NPK and organic fertilizers on soil properties and growth, antioxidant enzymes in leaves and yield of lettuce (Lactuca sativa var. Parris Island) Research on Crops.19 (3) : 441-449. DOI : 10.31830/2348-7542.2018.0001.14

[3] Glamoclija D, Jankovic S, Rakic S, Maletic R, Ikanovic J and Lakic Z.(2011).Effects of nitrogen and harvesting time on chemical composition of biomass of Sudan grass, forage sorghum, and their hybrid. Turk. J. Agricult. Forestry 35, 127-138.

[4] Uzun, F., Ugur, S. and M. Sulak, (2009) .Yield, nutritional and chemical properties of some sorghum x sudan grass hybrids (Sorghum bicolor L. Moench x Sorghum sudanense Stapf.). Journal of Animal and Veterinary Advances, 8: 1602-1608 .

[5] Casler, M.D., J.F. Pedersen and D.J. Undersander. (2003). Forage yield and economic losses associated with the brown-midrib trait in Sudangrass. Crop Sci., 43(3): 782-789.

[6] Pratt, P.F., S. Davis, R.G. Sharpless, W.J. Pugh and S.E. Bishop. (1976). Nitrate contents of Sudangrass and Barley forages grown on plots treated with animal manures. Agron. J.68(2): 311-314 .

[7] Venuto, B. and B. Kindiger. (2008). Forage and biomass feedstock production from hybrid forage sorghum and Sorghum–Sudangrass hybrids. Grassland sci., 54(4): 189-196.

[8] Mahmood, S. S., Taha,S. M., Al-Waeli, A. M. T. and AL-Taey, D. K. A. 2020. Integrated agricultural management off saline soils of Sowaira, Wasit Governorate. Int. J. Agricult. Stat. Sci., 16(1): 113-119.

[9] Hussain, I., I. Ali, S Ullah, A. Iqbal, A.R. Al Tawaha, A.R. Al-Tawaha, D. Thangadurai, J Sangeetha, A. Rauf, P. Saranraj, W. Al Sultan, D.K.A. AL-Taey, R.A. Youssef, S.N. Sirajuddin.(2021). Agricultural soil reclamation and restoration of soil organic matter and nutrients via application of organic, inorganic and bio fertilization. IOP Conf. Series: Earth and Environmental Science 788 (2021) 012165. doi:10.1088/1755-1315/788/1/012165

[10] Ros, M.B.H., G.F. Koopmans, K.J. Groenigen et al., (2020) : Towards optimal use of phosphorus fertilizer. Sci. Rep. 10: 17804

[11] AL-Taey , D.K.A. , S. S. Alftlawi and M. R. Sahib.(2022). EFFECT OF ZYTONIC-M, PALM WASTES COMPOST AND NPK ON THEGROWTH AND YIELD OF TOMATO UNDER SALT

STRESSCONDITIONS. Int. J. Agricult. Stat. Sci., 18(2): 829-836. DocID: https://connectjournals.com/03899.2022.18.829
[12] Khalid, M., A. Ijaz and A. Muhammad, 2003 : Effect of nitrogen and phosphorus on the fodder yield and quality of two Sorghum cultivars (Sorghum bicolor L.). Int. J. Agri. Biol., 5(1): 61-63
[13] Figueiredo, D.D., P.M. Barros, A.M. Cordeiro, T.S. Serra, T. Lourenço, S. Chander, M.M. Oliveira, N.J. Saibo, .(2012) : Seven zinc-finger transcription factors are novel regulators of the stress responsive gene OsDREB1B. J.of Exp. Bot., 63: 3643-3656.
[14] Manea, A. I., H. J. AL-Bayati, and D.K.A. AL-Taey .(2019). Impact of yeast extract, zinc sulphate and organic fertilizers spraying on potato growth and yield. Res. on Crops 20 (1) : 95-100. DOI : 10.31830/2348-7542.2019.013.
[15] Oosterhuis, D., K. Hake and C. Burmester, 1991 : Foliar feeding cotton. Cotton Physiol. Today, 2 : 1-7.
[16] Al-Aboudy, S.B. A. and Alabdulla S. A.(2022). Forage yield production of Sudangrass (Sorghum vulgare var.sudanense) as influenced by rates and split application of nitrogen. Biochem. Cell. Arch. Vol. 22, No. 1, pp. 3039-3043, 2022
[17] Cresser, M. S., & Parsons, J. W. (1979). Sulphuric—Perchloric acid digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. Analytica Chimica Acta, 109(2), 431-436.
[18] Bremner J. M., 1970 Regular Kjeldahl methods. In: Methods of soil analysis. Page A. L., Miller R. H., Keereny D. R. (eds), Part 2, 2nd edition, ASA Inc Madison, Wisconsin, U.S.A.
[19] Murphy T., Riley J. R., (1962). A modified single solution method for the determination of phosphate in natural waters. Anal Chem Acta 27:31-36
[20] Page A. L., Miller, R. H.and Keeney D. R., (1982). Methods of soil analysis. Part 2, 2nd edition. ASA Inc. Madison, Wisconsin, U.S.A.
[21] Steel R. G. D,, Torrie, J. H. and Dicky D. A. (1997) Principles and procedures of statistics. Biological approach, McGraw Hill book Co., New York ,NY,USA, 3rd edition ,1997.
[22] Balemi T.; Negisho K. Management of soil phosphorus and plant adaptation mechanisms to phosphorus stress for sustainable crop production: A review. J. Soil Sci. Plant Nutr. 2012, 12, 547–561
[23] Alabdalsayid, K. K.A and Al-Freeh,L. M.S.(2021). Effect of phosphate fertilization and Iron spraying on growth parameter and yield of Oat (Avena Sativa L.). IOP Conf. Series: Earth and Environmental Science 923 (2021) 012086 IOP Publishing doi:10.1088/1755-1315/923/1/012086
[24] Laftah, S. K. and Alabdulla, S. A.(2022). Response of Some Growth Traits of Safflower(Carthamus tinctorius L.) to Spray with Humic Acid Under Levels of Phosphorus Fertilizer . IOP Conf. Series: Earth and Environmental Science 1060 (2022) 012115 .doi:10.1088/1755-1315/1060/1/012115.
[25] Ayub, M., M. A. Nadeem, M. S. Shara and N. Mahmood, 2002 : Response of Maize (Zea mays L) fodder to different levels of Nitrogen and Phosphorus. Asian. J. Plant Sci., 1(4): 352-354
[26] Roy PRS, khandakar ZH (2010). Effect of Phosphorus fertilizer on yield and nutritional value of sorghum (sorghum bicolor) fodder at three cuttings. Bangladesh J. Anim.sci. 39(1-2): 106-115.
[27] Ajeigbe1,H.A.; Akinseye,F. M.; Jonah ,J and Kunihya, A.(2018). Sorghum yield and water use under phosphorus, fertilization applications in the Sudan savanna of Nigeria. Global Advanced Research J. of Agric. Sci. (ISSN: 2315-5094) Vol. 7(8) pp. 245-257
[28] Attia, H. G. and K. A. Jadoo. 1999. Practical and Theoretical Phyto-Growth Regulaters. Scientific Research and High Education. Baghdad, Iraq. p.11-20.
[29] Al-Shumary, A.M. J.(2020). The role of foliar zinc application on growth and yield of Faba bean varieties. Int. J. Agricult. Stat. Sci. Vol. 16, Supplement 1, pp. 1157-1161, 2020
[30] Awad A.; S Hafiz,S.; Hammada ,M. ; El-Hendawy ,S. ; Ali. E. and El-Nouby,A.(2014). Influence of phosphorous, nitrogenous fertilizers and seeding rates on green forge yield and its quality of Sudangrass (Sorghum vulgare var. Sudanense (Piper) Stapf) under Ismailia governorate conditions-Egypt J. of Plant Production Sciences,2(1):15-22.