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Effect of NPK Fertilization in the Newly Reclaimed Soil on Productivity of Grain Sorghum

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Abstract

A field experiment was conducted in the Agricultural Research Station at Arab El-Awamer, Assiut Governorate, during the two growing seasons of 2014 and 2015 to investigate the effect of NPK fertilization in newly reclaimed soil on grain sorghum productivity. The randomized complete block design using split-split-plot with four replications was arrangement, where nitrogen fertilizer rates (100, 120 and 140 kg N/fed. i.e. N_1, N_2 and N_3, respectively) were allocated in the main plots, while phosphorus fertilizer rates (22.5 and 30 kg P_2O_5/fed. i.e. P_1 and P_2, respectively) were assigned in the sub-plots and potassium fertilizer rates (24 and 36 kg K_2O/fed. i.e. K_1 and K_2, respectively) were fixed in the sub-sub-plots. The grains of sorghum Hybrid 305 was sown on 13th and 17th June in the first and second seasons, respectively. The plot area was 12 m^2 including 4 ridges of 60 cm apart with 4 m length. The results could be summarized as the following:

- The plant height in both seasons and the panicle length, 1000 grain weight and grain yield/fed. in the second season only, were increased with increasing N fertilizer rates up to 120 kg N/fed., as well as the highest mean values for panicle width, grains weight/panicle in both season and panicle length, 1000 grain weight and grain yield/fed. in the first season were recorded by 100 kg N/fed.
- Also, the mean values for all the studied traits were increased by increasing P fertilizer rates in both seasons.
- Here too, the lowest K fertilizer rate (24 kg K_2O/fed.) gave the highest mean values of grains weight/panicle, 1000-grain weight and grain yield/fed. in the first season, while the highest K fertilizer rate (36 kg K_2O/fed.) gave the highest mean values for the same traits in the 2nd season.
- In general, the first order interaction either N_3xP_1 or N_3xP_2 and N_3xK_1 or N_3xK_2 as well as P1xK1 or P1xK2 interaction treatments gave the lowest mean values for all the studied traits.
- Also, the maximum grain yield/fed. (21.46 and 22.78 ard.) were recorded by $N_1xP_2xK_1$ and $N_2xP_2xK_1$ interaction treatments in the 1st and 2nd seasons, respectively.

Keywords: *Sorghum, NPK fertilization rates, and yield and its components.*

Introduction

Sorghum is the fifth most important cereal crop grown for animal and human consumption in the world. In Egypt, reclaimed soils are often deficient in N, P and K, hence response to the three mineral fertilizers is universal. Nitrogen, phosphorus

and potassium are the essential elements required for plant growth in relatively large amounts. However, deficiencies of nitrogen and phosphorus are common. Fertilizers are an efficient exogenous source of plant nutrient. In Egypt, fertilizer use is insufficient and imbalanced. Balanced fertilizer use can help reverse environmental degradation by providing much needed nutrients to soil, thereby increasing crop yields. Shortriya (1998) reported that balanced application of NPK caused an increase in sorghum yield up to 122% of the recorded, in India. Here too, nutrient inputs from chemical fertilizers are needed to replace nutrient are exported and last during cropping, to maintain positive nutrient balances (Bauh and Mwinkaard, 2009). Many studied have been published on N, P or K fertilizer response in sorghum (Varvel & Wilhelm, 2003 and Kayuki *et al*., 2007), but these studied were limited to single nutrients and did not include a combination of nutrients. Alike, Allam *et al*. (2002) stated that the application of nitrogen fertilizer exerted a significant influence on panicle weight, seed index and grain yield/fed. of sorghum. Ashiono *et al*. (2005) confirmed that nitrogen level beyond 40 kg/ha and phosphorus level beyond 30 kg/ha did not increase plant height, seed weight and grain yield. They added that the optimum sorghum grain yield was attained at 40 kg N/ha and 20 kg P_2O_5/ha. El-Aref *et al*. (2005) reported that grain sorghum cultivars affected significantly by nitrogen fertilization and increase panicle weight, 1000 grain weight and grain yield. Akram *et al*. (2007) declared that P enhanced the crop growth and yield more than K and the best results were observed with their combined application. Moreover, maximum biological and grain yield of sorghum were 31.7 and 2.26 t/ha under P+K. Miko and Manga (2008) declared that nitrogen significantly influenced on plant height and grain yield. Afzal *et al*. (2012) noted that the plant height was increased by increasing nitrogen levels. Buah *et al*. (2012) cleared that fertilizer N, P and K did not show significant interactions for any parameter, across years, added K did not influence grain yield and yield components. However, P increased yield by 14% and N effected yield in a quadratic manner. Abou-Amer & Kewan (2014) reported that application of the highest rates of N (40 kg N/fed.) and P (40 kg P_2O_5/fed.) increased grain sorghum yields. Ayat *et al*. (2014) found that the application of NPK fertilizers exerted a significant influence on plant height, panicle weight, seed index and grain yield/fed. of sorghum and the maximum mean values for these traits were obtained by 125% NPK/fed. of the recommended fertilizers (100, 31 and 24 unit/fed. N, P and K, respectively) in both seasons. Zand *et al*. (2014) concluded that the effect of nitrogen application rate was significant for grain yield, but it did not significant for 1000 grain weight.

Gebremariam and Assefa (2015) cleared that application of N-fertilizer significantly increased plant height, panicle length, yield per panicle, 1000 grain weight and grain yield over the control. Highest responses of these parameters were obtained with application of 150 kg N/ha.

Sujathamma *et al*. (2015) showed that application of 100% recommended dose of fertilizer (N-P_2O_5-K-80-40-40) to sorghum plants recorded the highest mean values for panicle length, and grain yield/ha.

To achieve higher yield of crops, it is essential to provide them the optimum level of their nutrients requirements. Therefore, present study was conducted to determine the response of grain sorghum to application of combined N, P and K fertilizer in newly reclaimed soil.

Materials and Methods

The present investigation was carried out in the Agricultural Research Station at Arab El-Awammer in Assiut Governorate, during the two growing season of 2014 and 2015 to study the effect of NPK fertilization in newly reclaimed soil on the productivity of grain sorghum. The soil used for these experiments was sandy and its structure as presented in Table 1.

Table 1. The average physical and chemical analysis of the experimental site before cultivation in both seasons.

Physical properties:									
Particle size distribution (%)			Texture class	O.M (%)	$CaCO_3$ (%)	Moisture content (volumetric %)			A.W (%)
Sand	Silt	Clay				S.P.	F.C.	W.P.	
89.9	7.1	3.0	Sandy	0.25	30.9	23.3	10.9	4.5	6.5

Chemical properties									
pH (1:1)	EC dS/m (1:1)	Soluble cations (meq/L)				Soluble anions (meq/L)		Available phosphorus (ppm)	Total nitrogen (%)
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--} + HCO_3^{-}	Cl^{-}		
8.37	0.33	1.43	1.16	0.19	0.75	1.68	1.47	8.31	0.0125

O.M: Organic matter, S.P.: Saturation point, F.C.: Field capacity, W.P.: Wilting point, A.W.: Available water.

Experimental Design:

The field experiment was carried in a randomized complete block design (RCBD) using a split-split plot arrangement with four replications. The nitrogen fertilizer rates (100, 120 and 140 kg N/fed.) were assigned in the main plot, while the phosphorus fertilizer rates (22.5 and 30 kg P_2O_5/fed.) were affected in the sub plot and potassium fertilizer rates (24 and 36 kg K_2O/fed.) were fixed in the sub-sub plots.

The experimental unit area was 12 m^2 (3x4) including 4 ridges (4 m length) of 60 cm apart at spacing 20 cm between hills. Nitrogen fertilizer in the from ammonium nitrate (33.5% N) and potassium sulphate (48% K_2O) were divided into four equal dose: (1) The first dose was added after 10 days from sowing. (2) The second dose was added after 38 days from sowing. (3) The third dose was added after 52 days from sowing. (4) The fourth dose was added after 68 days from sowing. Moreover, calcium super phosphate (15.5% P_2O_5) was applied at sowing.

Grain sorghum variety Hybrid 305 was hand sown on 13st and 17th June in the first and second seasons,

respectively. After three weeks from planting, plants were thinned into two plants per hill. The preceding crop was wheat in the both season. All other agricultural practices were carried out as recommended for grain sorghum in both seasons.

Characters, sampling and measurement:

Data were recorded by using competitive plants from each sub-sub plot (12 m^2). A plant was considered competitive when it was guarded from four sides, i.e. two sides on the same ridge and the other two sides on the adjacent ridges. Random samples of five plants were chosen from the four inner rows of every sub-sub plot.

The following characters were recorded:

Plant height (cm): measured from soil surface to the tip of the panicle, panicle length (cm): measured from the base to the tip of the panicle, panicle width (cm), grain weight of panicle (gm), seed index (g) and grain yield/fed (ard.): it was estimated from the plot area in kg/plot and converted into ardab/fed.

Statistical analysis:

The obtained data from each season were exposed to proper statistical analysis of variance according to Gomez and Gomez (1984) using the MSTAT Statistical Software package described by Co-Stat (2004). The revised least significant differences (RLSD) at 5% level of probability were computed to detect the differences among means.

Results and Discussion

Main effects:

Data in Table 2 revealed that the all studied traits i.e. plant height, panicles length, width and grains weight, 1000 grain weight and grain yield/fed. were significantly affected by the nitrogen fertilizer rates in both seasons, except panicle width in the 1st season did not significant affect by this trail. The plant height in both seasons and the panicle length, 1000 grain weight and grain yield/fed. in the second season were increased by increasing N fertilizer rates up to 120 kg/fed. As well as, the highest mean values of panicles width and weight in both seasons and panicle length, 1000 grain weight and grain yield/fed. in the 1st season were recorded by 100 kg N/fed. These results mean either the medium or the lowest N fertilizer rate gave the highest mean values for the all studied traits. It is clear from these data that N fertilizer to grain sorghum enhanced the vegetative growth of the plants, increased photosynthetic activity and the metabolites required to produce wide and heavy panicles, increase grains weight and consequently produce the higher grain yield. These results coincide with mentioned by Allam *et al*. (2002), El-Aref *et al*. (2005), Buah & Mwinkaara (2009), Afazal *et al*. (2012), Buah *et al*. (2012), Zand *et al*. (2014), Ayat *et al*. (2014) and Gebremarium & Assefa (2015) who reported that application of N-fertilizer significantly increased plant height, panicle length, yield per panicle, 100 grain weight and grain yield over the control. As well as Sujathamma *et al*. (2015) came the same conclusion.

Regarding to phosphorus fertilizer rates, the results in Table 2 showed that the plant height in both seasons and panicles length and weight, 1000 grain weight and grain

yield/fed. in the 2nd season were affected significantly by this trail. Generally, the all studied traits increased by increasing P fertilizer rates in both season. These results may be due to the adding P fertilizer was useful efficiency for the crop for nutrients that giving good chance for growth. Added P fertilizer increased biomass and grain production at Arab El-Awamer soil that tested low in available P (8.31 ppm in Table 1). These findings are in agreement with those stated by El-Kased and Nnandy (1987), Wortmann *et al*. (2006), Khalili *et al*. (2008), Roy and Khandaker (2010) and Abou-Amer and Kewan (2014) who concluded that application of the highest rate of P (40 kg P_2O_5/fed.) increased grain sorghum yield.

Concerning with potassium fertilizer rates, the results in Table 2 declared that panicle length, 1000 grain weight and grain yield/fed. in the 2nd season as well as grains weight/panicle in both seasons exerted significantly or highly significantly affected by this trail, while the plant height and panicle width in both seasons as well as panicle length, 1000 grain weight and grain yield/fed. in the first season did not significantly affected by this trail. Buah *et al*. (2012) reported that grain yield and yield components were not significantly affected by add K fertilizer. The highest mean values of grains weight/panicle (40.26 g), 1000 grain weight (26.41 g) and grain yield/fed. (19.47 ard.) were obtained by the highest K fertilizer rate in the 2nd season, alike panicle length (25.30 cm) in the 2nd season and grains weight/panicle (35.77 g) and grain yield/fed. (17.89 ard.) in the 1st season were obtained by the lowest K fertilizer rate. These results declared that either the highest or the lowest K fertilizer rates gave the highest values for different studied traits and consequence there are indirect same trend for this trail. Sharma & Kumari (1996) reported that with increased K fertilizer application, sorghum grew better (taller plant) and had higher, yield. Quintero *et al*. (1998) observed that K fertilization is associated with increasing crop growth because of the positive effect of this nutrient in osmotic adjustment stomat regulation, photosynthesis and protein synthesis. Similar findings were reported by Umer (2006), Saleem *et al*. (2011) and Buah *et al*. (2012).

Table 2. Main effect of nitrogen, phosphorus and potassium fertilizer on the plant height, yield components and yield for grain sorghum in 2014 and 2015 seasons.

Characters / Main effects	Plant height (cm)		Panicle length (cm)		Panicle width (cm)		Grains weight/ panicle (g)		1000 grain weight (g)		Gra yield/ (ard
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014
Nitrogen (N)											
N_1	142.2	140.9	26.01	24.98	6.42	6.86	39.83	41.07	24.40	25.63	19.91
N_2	143.7	144.3	25.65	25.60	6.29	6.84	35.70	40.96	23.74	27.78	17.83
N_3	125.3	138.4	24.56	23.64	6.38	5.82	30.30	36.19	22.79	23.74	15.18
F-test	**	**	**	**	N.S.	**	**	**	**	**	**
RLSD 5%	1.94	1.86	0.56	0.52	0.19	0.23	0.79	0.49	0.31	0.53	0.52
Phosphorus (P)											
P_1	135.3	138.7	25.68	24.04	6.40	6.58	35.23	37.70	23.53	25.04	17.64
P_2	138.9	143.8	25.13	25.43	6.33	6.43	35.33	41.11	23.75	26.39	17.64
F-test	**	**	N.S	**	N.S	N.S.	N.S.	**	N.S	**	N.S.
Potassium (K)											
K_1	137.7	141.0	25.53	25.30	6.33	6.59	35.77	38.55	23.73	25.02	17.89
K_2	136.5	141.4	25.28	24.18	6.40	6.43	34.78	40.26	23.55	26.41	17.39
F-test	N.S.	N.S.	N.S	**	N.S	N.S	**	**	N.S	**	N.S

N_1 = 100 kg N/fed., **N_2** = 120 kg N/fed., **N_3** = 140 kg N/fed., **P_1** = 22.5 kg P_2O_5/fed., **P_2** = 30 kg P_2O_5/fed.,

K_1 = 24 kg K_2O/fed., **K_2** = 36 kg K_2O/fed.

*, ** indicated to significantly and highly significantly at 5% and 1% levels of probability, respectively.

N.S. = Non-significant differences. RLSD = Revised Least Significant Difference.

Interaction effects:

Data in Table 3 cleared that the NxP (nitrogen x phosphorus) interaction had a highly significantly effect on the all studied traits, except grains weight/panicle and grain yield/fed. in the 1st season as well as panicle width in the 2nd season. The tallest plant (148.3 cm), maximum grain yield/fed. (20.25 ard.) in the 1st season, tallest panicle (26.23 cm) in the 2nd season, the heaviest panicle grains (40.50 and 44.11 g) and heaviest 1000 grain (25.60 and 28.63 g) in both season were obtained by N_1xP_2 (100 kg N x 30 kg P_2O_5/fed.) interaction treatment. Bauh *et al*. (2012) declared that NxP interaction did not show significant influence for any parameters. Here too, the tallest panicle (27.08 cm) and the widest panicle (6.60 cm) in the 1st season were recorded by N_1xP_1 (100 kg N x 22.5 kg P_2O_5/fed.) interaction treatments. As well as the tallest plant (146.3 cm) and the maximum grain yield/fed. (21.60 ard.) in the 2nd season were detected by N_2xP_1 (120 kg N x 22.5 kg P_2O_5/fed.) and N_2xP_2 (120 kg N x 30 kg P_2O_5/fed.) interaction treatments, respectively. On the other hand, in general, either N_3xP_1 (140 kg N x 22.5 kg P_2O_5/fed.) or N_3xP_2 (140 kg N x 30 kg P_2O_5/fed.) interaction treatment gave the lowest values for all the studied traits. These results are in conformity with those obtained by Ashiono *et al*. (2005) who reported that application of 40 kg N/ha and 20 kg P/ha produced the highest grain yield (9.85 tons/ha), However, the tallest plant (162 cm) was at 40 kg N/ha and either 30 kg P or 90 kg P/ha, as well as, the greatest 100 kernel weight (2.3 g) was at 40 kg N/ha with 50 kg P/ha.

With attention to the NxK (nitrogen x potassium) interaction, the results in Table 4 revealed that the all studied traits exerted highly significantly influenced by this interaction, except plant height in the 1st season and panicle length in the 2nd season did not show any significant. The N_1xK_1 (100 kg N x 24 kg K_2O/fed.) interaction treatment realized the highest values for panicle length (26.85 cm), panicle width (6.64 cm), grains weight/panicle (41.08 g) and grain yield/fed. (20.54 ard.) in the 1st season.

Table 3. Interaction effect of nitrogen x phosphorus fertilizer (NxP) on the plant height, yield components and yield for grain sorghum in 2014 and 2015 seasons.

Characters N x P		Plant height (cm)		Panicle length (cm)		Panicle width (cm)		Grains weight/ panicle (g)		1000 grain weight (g)		Grai yield/f	
		2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	
N_1	P_1	136.2	138.1	27.08	23.73	6.60	6.24	39.15	38.03	23.20	22.63	19.58	1
	P_2	148.3	143.6	24.95	26.23	6.25	6.99	40.50	44.11	25.60	28.63	20.25	1
N_2	P_1	143.2	146.3	25.35	25.58	6.18	7.05	36.00	38.75	24.05	27.44	18.02	1
	P_2	144.2	142.4	25.95	25.63	6.41	6.63	35.40	43.18	23.43	28.13	17.64	2
N_3	P_1	126.5	131.6	24.63	22.83	6.41	5.96	30.53	36.33	23.35	25.06	15.32	1
	P_2	124.2	145.3	24.50	24.45	6.34	5.68	30.08	36.05	22.23	22.43	15.04	1
F-test		**	**	**	**	**	N.S	N.S.	**	**	**	N.S	
RLSD 5%		2.6	0.88	0.89	0.36	0.19	0.41	1.42	0.53	0.68	0.70	1.28	

N_1 = 100 kg N/fed., **N_2** = 120 kg N/fed., **N_3** = 140 kg N/fed., **P_1** = 22.5 kg P_2O_5/fed., **P_2** = 30 kg P_2O_5/fed.,
K_1 = 24 kg K_2O/fed., **K_2** = 36 kg K_2O/fed.
*, ** indicated to significantly and highly significantly at 5% and 1% levels of probability, respectively.
N.S. = Non-significant differences. RLSD = Revised Least Significant Difference.

Table 4. Interaction effect of nitrogen x potassium fertilizers (NxK) and phosphorus x potassium fertilizer (PxK) on the plant height, yield components and yield for grain sorghum in 2014 and 2015 seasons.

Characters / N x K		Plant height (cm)		Panicle length (cm)		Panicle width (cm)		Grains weight/ panicle (g)		1000 grain weight (g)		Grai yield/f	
		2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	
N_1	K_1	142.2	137.3	26.85	25.50	6.64	6.60	41.08	38.04	23.70	22.88	20.54	1
	K_2	142.3	144.5	25.18	24.45	6.21	7.13	38.58	44.10	25.10	28.38	19.29	2
N_2	K_1	143.7	150.6	25.23	26.15	6.21	7.23	34.48	42.45	23.53	27.44	17.20	2
	K_2	143.7	138.0	26.08	25.05	6.38	6.45	36.93	39.48	23.95	28.13	18.45	1
N_3	K_1	127.3	135.1	24.53	24.25	6.14	5.94	31.76	35.18	23.98	24.75	15.94	1
	K_2	123.4	141.8	24.60	23.03	6.61	5.70	28.84	37.20	21.60	22.74	14.42	1
F-test		N.S	**	**	N.S	**	**	**	**	**	**	**	
RLSD 5%		3.10	0.80	1.03	-	0.20	0.27	0.70	0.66	0.52	0.57	0.87	
P x K													
P_1	K_1	138.1	136.3	26.62	24.40	6.45	6.72	36.64	35.30	23.40	23.67	18.38	1
	K_2	132.5	141.0	24.75	23.68	6.34	6.45	33.81	40.10	23.67	26.42	16.90	2
P_2	K_1	137.3	145.7	24.45	26.20	6.21	6.46	34.90	41.81	24.07	26.38	17.41	2
	K_2	140.5	141.8	25.82	24.67	6.46	6.40	35.75	40.42	23.43	26.41	17.88	1
F-test		**	**	**	**	**	N.S.	**	**	*	**	**	
RLSD 5%		2.17	0.66	0.75	0.36	0.17	0.30	0.57	0.54	0.48	0.47	0.71	

N_1 = 100 kg N/fed., **N_2** = 120 kg N/fed., **N_3** = 140 kg N/fed., **P_1** = 22.5 kg P_2O_5/fed., **P_2** = 30 kg P_2O_5/fed.,
K_1 = 24 kg K_2O/fed., **K_2** = 36 kg K_2O/fed.
*, ** indicated to significantly and highly significantly at 5% and 1% levels of probability, respectively.
N.S. = Non-significant differences. RLSD = Revised Least Significant Difference.

As well as, the N_1xK_2 (100 kg N x 36 kg K_2O/fed.) interaction realized the highest mean values of grains weight/panicle (44.10 g) and 1000 grain weight (25.10 and 28.38) in the 1st and 2nd seasons, respectively. Moreover, the N_2xK_1 interaction gave the highest mean values of plant height (150.6 cm), panicle length (26.15 cm), panicle width (7.23 cm) and maximum grain yield (21.24 ard.) in the 2nd season. On the contrary, overall either N_3xK_1 or N_3xK_2 (120 kg N x 24 kg K_2O/fed.) or (120 kg N x 36 kg K_2O/fed.) interaction treatment recorded the lowest values for all the studied traits. Buah *et al*. (2012) mentioned that any parameter had not significantly affected by NxK interaction treatments.

As far the PxK (phosphorus x potassium) interaction, data in Table 4 indicated that the all studied traits were affected significantly by this interaction in both seasons, except panicle width in the 2nd season. The P_1xK_1 (22.5 P_2O_5 x 24 kg K_2O/fed.) interaction treatment pointed out the highest values for panicle length (26.26 cm), grain weight/panicle (36.64 g) and grain yield/fed. (18.38 ard.) in the 1st season. As well as, P_2xK_1 (30 kg P_2O_5 x 24 kg K_2O/fed.) interaction treatment confirmed the highest values for plant height (145.7 cm), panicle length (26.20 cm), grain weight/panicle (41.81 g) and grain yield/fed. (20.43 ard.) in the 2nd season, whereas the heaviest 1000 grain (24.07 g) was found in the 1st season. Moreover, the P_2xK_2 interaction treatment decided the tallest plant (140.5 cm) and tallest panicle (6.46 cm) in the 1st season. On other hand, in general, either P_1xK_1 or P_1xK_2 (22.5 P_2O_5 x 24 kg K_2O/fed.) or (22.5 P_2O_5 x 36 kg K_2O/fed.) interaction treatment illustrated the lowest values for all studied traits. Buah *et al*. (2012) noted that PxK interaction was not significant for any studied parameters.

With respect to the second order interaction (nitrogen x phosphorus x potassium), data in Table 5 reported that the all studied traits exerted significantly or highly significantly influenced by the second order interaction, except panicle width in both seasons. The tallest plants (150.1 and 154.8 cm) were recorded by $N_1xP_2xK_1$ and $N_2xP_2xK_1$ (100 kg N x 30 kg P_2O_5 x 24 kg K_2O/fed.) and (120 kg N x 30 kg P_2O_5 x 24 kg K_2O/fed.) interaction treatments; the tallest panicles (28.45 cm and 27.25 cm) were obtained by $N_1xP_1xK_1$ and $N_1xP_2xK_1$ (100 kg N x 22.5 kg P_2O_5 x 24 kg K_2O/fed.) and (100 kg N x 30 kg P_2O_5 x 24 kg K_2O/fed.) interaction treatments; the heaviest grains/panicle (42.93 and 44.75 g) were detected by $N_1xP_2xK_1$ and $N_1xP_2xK_2$ (100 kg N x 30 kg P_2O_5 x 24 kg K_2O/fed.) and (100 kg N x 30 kg P_2O_5 x 36 kg K_2O/fed.) interaction treatments; the heaviest 1000 grain (26.00 and 29.38 g) were observed at $N_1xP_2xK_2$ (100 kg N x 30 kg P_2O_5 x 36 kg K_2O/fed.) and the maximum grain yield/fed. (21.46 and 22.78 ard.) were recorded by $N_1xP_2xK_1$ and $N_2xP_2xK_1$ (100 kg N x 30 kg P_2O_5 x 24 kg K_2O/fed.) and (120 kg N x 30 kg P_2O_5 x 24 kg K_2O/fed.) interaction treatments in the 1st and 2nd seasons, respectively. On the contrary, overall, N_3 with P_1 or P_2 and with K_1 or K_2 recorded the lowest values for all traits in this study. Buah *et al*. (2012) reported that NxPxK interaction was not significant for 1000 kernel weight and grain yield.

Table 5. Effect of the second order interaction (NxPxK) on the plant height, yield components and yield for grain sorghum in 2014 and 2015 seasons.

Characters / NxPxK		Plant height (cm)				Panicle length (cm)				Panicle width (cm)			
		2014		2015		2014		2015		2014		2015	
		K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2
N_1	P_1	134.2	138.7	135.5	140.8	28.45	25.70	23.75	23.70	6.85	6.35	6.50	6.98
	P_2	150.1	146.6	139.0	148.3	25.25	24.65	27.25	25.20	6.43	6.08	6.70	7.28
N_2	P_1	145.5	140.9	146.5	146.0	25.40	25.30	25.80	25.35	6.13	6.23	7.53	6.58
	P_2	142.0	146.5	154.8	130.0	25.05	26.85	26.50	24.75	6.30	6.53	6.92	6.33
N_3	P_1	134.7	118.4	127.0	136.3	26.00	23.25	23.65	22.00	6.38	6.45	6.13	5.80
	P_2	119.9	128.5	143.3	147.3	23.05	25.95	24.85	24.05	5.90	6.78	5.75	5.60
F-test		**		**		*		*		N.S		N.S	
RLSD 5%		3.67		1.36		1.51		0.63		0.32		-	

Characters / NxPxK		Grains weight/panicle (g)				1000 grain weight (g)				Grain yield/fed.			
		2014		2015		2014		2015		2014		2015	
		K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2
N_1	P_1	39.23	39.08	32.60	43.45	22.20	24.20	17.88	27.38	19.61	19.54	16.30	21.73
	P_2	42.93	38.08	43.48	44.75	25.20	26.00	27.88	29.38	21.46	19.04	19.99	18.43
N_2	P_1	35.46	36.55	39.40	38.10	24.00	24.10	26.63	28.25	17.78	18.26	19.70	19.05
	P_2	33.50	37.30	34.50	40.85	23.05	23.80	28.25	28.00	16.63	18.65	22.78	20.43
N_3	P_1	35.25	25.80	33.90	38.75	24.00	22.70	26.50	23.63	17.74	12.91	16.70	19.38
	P_2	28.28	31.88	36.45	35.65	23.95	20.50	23.00	21.85	14.14	15.94	18.25	17.83
F-test		**		**		*		**		**		**	
RLSD 5%		0.99		0.97		0.83		0.81		0.64		0.88	

N_1 = 100 kg N/fed., **N_2** = 120 kg N/fed., **N_3** = 140 kg N/fed., **P_1** = 22.5 kg P_2O_5/fed., **P_2** = 30 kg P_2O_5/fed.,
K_1 = 24 kg K_2O/fed., **K_2** = 36 kg K_2O/fed.
*, ** indicated to significantly and highly significantly at 5% and 1% levels of probability, respectively.
N.S. = Non-significant differences. RLSD = Revised Least Significant Difference.

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تأثير التسميد بالنيتروجين والفوسفور والبوتاسيوم في الأراضي حديثة الإستصلاح علي إنتاجية الذرة الرفيعة للحبوب

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الملخص

أقيمت تجربة حقلية بمحطة البحوث الزراعية بعرب العوامر خلال موسمي الزراعة ٢٠١٤ و٢٠١٥ لبحث تأثير التسميد بعناصر النيتروجين والفوسفور والبوتاسيوم في الأراضي حديثة الإستصلاح علي إنتاجية الذرة الرفيعة للحبوب. وكان تصميم التجربة هو قطاعات كاملة العشوائية باستخدام الأحواض المنشقة مرتين في أربع مكررات، حيث تم وضع معدلات السماد النيتروجيني (١٠٠ ، ١٢٠ و ١٤٠ كجم ن/فدان) في القطع الرئيسية، بينما تم وضع معدلات السماد الفوسفوري (٢٢,٥ و ٣٠ كجم فو٢أ٥/فدان) في القطع المنشقة، كما تم وضع معدلات السماد البوتاسي (٢٤ و ٣٦ كجم بو٢أ/ فدان) في القطع تحت المنشقة. وتم زراعة الصنف هجين ٣٠٥ في ميعادي ١٣ و ١٧ يونيو في السنة الأولي والثانية علي الترتيب وكانت مساحة القطعة التجريبية هو ١٢ م^2 (٤ خطوط بمسافة ٦٠ سم بين الخطوط وطول الخط ٤ م).

ويمكن تلخيص أهم النتائج المتحصل عليها كما يلي:

- إزداد طول القنديل، وزن الألف حبة ومحصول الحبوب/ فدان في الموسم الثاني بزيادة معدل السماد النيتروجيني حتي ١٢٠ كجم ن/فدان، كما سجل أعلا متوسطات القيم لكل من عرض القنديل، وزن الحبوب/قنديل في كلا الموسمين وطول القنديل ، وزن الألف حبة ومحصول الحبوب/فدان في الموسم الأول بالتسميد بمعدل ١٠٠ جم ن/فدان.
- كما زادت متوسطات القيم لجميع الصفات المدروسة بزيادة معدلات السماد الفوسفوري في كلا الموسمين.
- أعطي أعلا معدل للسماد البوتاسي (٣٦ كجم بو٢أ/فدان) أعلي القيم لوزن الحبوب/قنديل، وزن الألف حبة ومحصول الحبوب/ فدان في الموسم الثاني، بينما أعطي أقل معدل للسماد البوتاسي (٢٤ كجم بو٢أ/فدان) أعلي القيم لنفس الصفات السابقة في الموسم الأول.
- بصفة عامة أظهرت التفاعلات من الدرجة الأولي أن التفاعل N_3xP_1 أو N_3xP_2 والتفاعل N_3xK_1 أو N_3xK_2 والتفاعل P_1xK_1 أو P_1xK_2 أقل القيم لجميع الصفات المدروسة.
- سجل التفاعل الثلاثي $N_1xP_2xK_1$ و $N_2xP_2xK_1$ أعلي متوسطات القيم لمحصول الحبوب/فدان (٢١,٤٦ و ٢٢,٧٨ أردب) في الموسم الأول والثاني علي الترتيب.