Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 05, NO. 01, 2020
http://www.nilevalley.edu.sd

Research paper

Effect of Different Fertilizers on Yield and Yield Components of Chickpea (*Cicer arietinum* L) on High Terrace Soil in the River Nile State, Sudan

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ABSTRACT

This study aimed to increase chickpea production in the River Nile State- Sudan by using different fertilizers in high terrace soil. A randomized complete block using split plot arrangement was used to layout the experiment. The treatments consisted of five fertilizers compilation Di-Amino-Phosphate (DAP) and compost. The levels were: control, 1DAP, 2DAP, 1DAP plus compost, and 2DAPplus compost. However, compost fertilizer was applied at rate of about 3.3 MT ha-1; one compost sack is equivalent to 100 kg of organic material, and 1DAP= 92.8 kg ha-1 while 2DAP= 185.6 kg ha-1 of N. Two local chickpea varieties Atmour and Borgag were tested. The treatments were arranged in split plot design with four replicates. Planting was on ridges 60cm apart and in-row spacing 10cm with 2 seeds per hole. Plot size was (6m x 6m). Sowing was on mid of November each season and irrigation was carried out every 7 days regularly. The results showed highly significant differences in plant height and number of pods per plant in both varieties Atmour and Borgeig. The highest plant height and number of pods per plant were observed when compost plus 2DAP was applied. Number of branches per plant was increased significantly with application of 2DAP. Both compost and DAP fertilizers had significant effect on 100 seed weight and the best 100 seed weight was achieved by application of compost plus 2DAP. The application of compost plus 2DAP significantly increased yield by 54 and 45% for both varieties Atmour and Borgeig in the first season. In the one hand, the increases in the second season was 69 and 67%. The maximum biological yield was attained by the treatment of compost plus 2DAP. The application of compost plus 2DAP has an economical benefit to farmers if they used the recommended packages, it realized Marginal rate of return (MRR) equals to about 2361%.

Keywords: Atmour, Borgeig, di-amino phosphate, compost.

أثر اضافة اسمدة مختلفة على الإنتاجية ومكوناتها لمحصول الحمص بأراضي التروس العليا بولاية نهر النيل، السودان

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1 محطة بحوث الحديبة، هيئة البحوث الزراعية
2 محطة بحوث شمبات، هيئة البحوث الزراعية

هدفت هذه الدراسة إلى زيادة إنتاج الحمص في ولاية نهر النيل بالسودان باستخدام الأسمدة المختلفة في اراضي التروس العليا. تم استخدام نظام المربعات كاملة العشوائية بترتيب القطع المنشقة لتخطيط التجربة. تتكون المعاملات من خمسة تراكيب من الأسمدة؛ ثنائي أمينو فوسفات (DAP) وسماد الكمبوست العضوي. كانت المستويات هي: دون اسمدة، وحدة من الداب DAP، وحدتين من الداب 2DAP، وحدة من الداب DAP بالإضافة إلى السماد العضوي، وحدتين من الداب DAP2 بالإضافة إلى السماد العضوي. تم استخدام سماد الكومبوست العضوي بمعدل حوالي 3.3 طن متري/ هكتار. كيس السماد الواحد يعادل 100 كجم من المواد العضوية، وحدة الداب= 92.8 كجم/ هكتار بينما وحدتي الداب= 2 185.6 كجم/ هكتار من النايتروجين. تم اختبار صنفين محليين من الحمص عتمور وبرقيق. تم ترتيب المعاملات في تصميم القطع المنشقة بأربعة مكررات. تمت الزراعة على سرابات تبعد 60 سم عن بعضها وعلى مسافة 10 سم على الخط وبذرتين لكل حفرة. حجم القطعة كان (6م×6م) تم البذر في منتصف شهر نوفمبر من كل موسم وكان الري كل 7 أيام بشكل منتظم. أظهرت النتائج اختلافات معنوية عالية في ارتفاع النبات وعدد القرون لكل نبات في كلا الصنفين عتمور وبرقيق. لوحظ أعلى ارتفاع للنبات وعدد القرون لكل نبات عند تطبيق سماد الكومبوست العضوي بالإضافة إلى وحدتين من الداب .لوحظ زيادة عدد الافرع لكل نبات بشكل ملحوظ مع تطبيق وحدتين من الداب كان لكل من سماد الكومبوست العضوي وأسمدة الداب DAP تأثير معنوي على وزن ال 100 بذرة وتم تحقيق أفضل وزن 100 بذرة عن طريق إضافة الكومبوست بالإضافة إلى وحدتين من الداب، زاد استخدام السماد العضوي بالإضافة إلى وحدتين من الداب الانتاجية بشكل ملحوظ بنسبة 54 و 45٪ لأصناف الحمص Atmour و Borgeig في الموسم الأول. من ناحية، كانت الزيادات في الموسم الثاني 69 و67٪. تم تحقيق أقصى إنتاج بيولوجي من خلال اضافة السماد العضوي بالإضافة إلى وحدتين من الداب. اضافة سماد الكومبوست العضوي بالإضافة إلى وحدتين من الداب له فائدة اقتصادية للمزارعين إذا استخدموا الحزم الموصى بها، فقد كان معدل العائد MRR من المعاملة حوالي 2361%.

كلمات مفتاحية: عتمور، برقيق، الداب، السماد العضوي

Introduction

Chickpea (*Cicer arietinum* L) is considered as a less labor intensive crop and its production requires less massive inputs compared to cereal crops. However, chickpea is widely grown worldwide and serve as multipurpose crop. The crop can fix up to 140 kg of Nitrogen per hectare area from air so it plays a significant role in improving soil fertility. Post-harvest operations can add substantial amount of residual nitrogen from plan leaves that act as nutrition source for successive crops and provides some amount of organic matters to maintain and improve soil texture and fertility. When chickpea grown in rotation with other crops, under certain environmental condition it can enhance soil fertility and reduce weed population, diseases, and pests (Chemining wa and Vessey, 2006). This mater can save fertilizers costs not only for the chickpea but also for the following crops. The crop ability to grow in the residual moisture gives farmers good chance to engage in double cropping that maximize the utility of their lands, in particular in the area where arable land is short.

Chickpea is a grain legume crop cultivated mainly for its nutritional value. Because of its high protein contents, it is considered as an important economical source of quality vegetable protein in human diet. It is an excellent source of protein, fiber, vitamins, complex carbohydrates, and minerals thus can contribute in malnutrition alleviation and improving human health.

Chickpea is considered as water stress resistant crop due to its deep tap root system that enables the crop to have good water supply by extracting water from deeper soil layers. The original place of growing chickpea is Middle East 7000 years ago but now the crop is grown in more than 20 countries worldwide. The main producing countries of chickpea is India, Turkey, Pakistan, Iran, Mexico, Australia, Ethiopia, Myanmar, and Canada. Nonetheless, chickpea is occupying about 11 million hectares worldwide with 65% and 8% share coming for India and Pakistan respectively.

The international chickpea production was about 9 million tons and 95% of its cultivation and consumption occurred in the third world. The crop residue is rich in digestive crude protein content that can increase livestock productivity. Chickpea needs about 60 lb nitrogen (N) for every 1000 lb of grain produced (Kurdali, 1996). In fact, about 70% or more of nitrogen in the plant comes from biological fixation, the reminder supplied through the soil as nitrate mineralized from organic matter or from starter fertilizer. In the Sudan, the crop is highly consumed specifically in Ramadan and as well considered as a cash crop. Usually average farmers yield is low compared to the demonstration plots. The great emphasis should be made on increasing yield quantity and quality. Therefore, this study aims to increase chickpea productivity in the River Nile State using different fertilizer sources and doses under high terraces soil.

Materials and methods

A field experiment was conducted at Hudeiba Research Farm during two successive winter seasons 2016/17 and 2017/18 to increase chickpea productivity in the River Nile State- Sudan using different fertilizers in high trace soil. In this trail, the treatments consisted of five fertilizers compilation Di-Amino-Phosphate (DAP) and compost. The levels were: control, 1DAP, 2DAP, 1DAP plus compost, 2DAP plus compost. However, compost fertilizer was applied at rate of about 3.3 MT ha^{-1}; one compost sack is equivalent to 100 kg of organic material, and 1DAP = 92.8 kg ha^{-1} while 2DAP= 185.6 kg ha^{-1} (N). Two local chickpea varieties Atmour and Borgaig are tested. The treatments were laid out in a randomized complete block using split plot arrangement with four replications.

Planting was on ridges 60 cm apart and in-row spacing 10 cm with 2 seeds per hole. Plot size was 6m x 6m, sowing was on 15 November and the irrigation was carried out every 7 days regularly.

Parameters determining vegetative, reproductive, yield and yield components were number of branches per plant, plant height (cm.), number of pods per plant, number of seeds per pod, 100-seeds weight (g.), and seed yield (kg ha^{-1}). Further, these data on yield components were subjected to a computer statistical program software GENSTST to be analyzed; and differences among treatment means were compared by least significant differences test (LSD).

Results and discussion

Table -3 shows the effect of fertilizers doses on vegetative and reproductive growth parameters of chickpea. There were highly significant differences in plant height and number of pods per plant in both varieties Atmour and Borgeig. The plant height was significantly affected by compost plus 2DAP. The highest plant height was observed when compost plus 2DAP (N=185.6 kg ha^{-1}) was applied. This result was in accord with the findings of Amany (2007) and Caliskan *et al.* (2008) who reported that plant height increased with application of nitrogen fertilizer. On the other hands, number of pods per plant showed highly significant differences to compost and DAP fertilizations. The highest number of pods per plant (60) was recorded in compost plus 2DAP. Mckenzie and Hill (1995) and Amany (2007) investigated the effect of nitrogen and iron fertilizer on chickpea and found that number of pods per plant increased significantly with increases of nitrogen doses up to 80 kg ha^{-1} as similar results were obtained by this study.

In the matter of number of branches there was no significant differences between (compost, 1DAP, compost plus1DAP and control) but it was highly significant between (compost, 1DAP, control and compost plus 2DAP) on variety Atmour. Number of branches per plant was increased significantly with application of 2DAP (N=185.6 kg ha^{-1}). That was because of additional amount of nitrogen coming from 2DAP. Results here are in agreement with that obtained by Rudresh *et al.* (2005) and Togay *et al.* (2008). Controversially, there was only significant differences between fertilizers and control with variety Borgeig.

The 100 seed weight character was highly significant between fertilizers in both varieties Borgeig and Atmour. Table 3 shows that the application of both of compost and DAP fertilizers had significant effect on 100seed weight. In significant, the best 100seed weight was found when the application of compost plus 2DAP (N=185.6 kg ha^{-1}). Healthy growth and well development of chickpea plant due to phosphorus (DAP) supply and nitrogen (Compost plus DAP) uptake might have increased the supply of photosynthates to seed, which ultimately gained more weight. Similar results were previously achieved by Kar *et al.* (1989), Singh and Hiremath (1990), Chauhan *et al.* (1992) and Anchal *et al.* (1997). Nonetheless, the total grain yield (P=0.01) due to application of (compost fertilizer plus 2DAP) was highly significant. Also, the interaction results between fertilizers and varieties were significant.

The maximum biological yield was attained by the treatment of compost plus 2DAP (N=185.6 kg ha^{-1}). Similar results obtained by Roy *et al*. (1995) who found that more plant growth, yield and yield components are the possible reason for more biological yield in treated plots.

Table (4) shows the Marginal Rate of Return (MRR). Marginal rate of return (MRR) is not only applicable to business; it is also can be used as individual tool to make private business. It defines as the amount of additional revenue that a business can expect to earn per each additional pound that it spends on production. The application of compost plus 2DAP has an economical benefit to farmers if they used the recommended packages, it realized MRR equals to about 2361%.

Conclusion

- The highest plant height was observed when compost plus 2DAP (N=185.6 kg ha^{-1}) was applied.
- The highest number of pods per plant (60) was recorded in application of compost plus 2DAP (N=185.6 kg ha^{-1}).

- Number of branches per plant was increased significantly with application of 2DAP (N=185.6 kg ha^{-1}).
- The best 100seed weight was found when the application of compost plus 2DAP (N=185.6 kg ha^{-1}).
- The maximum biological yield was achieved by the treatment of compost plus 2DAP (N=185.6 kg ha^{-1}).
- The application of compost plus 2DAP has an economical benefit to farmers**.**

References

Amany, A.B. (2007). Effect of plant density and urea foliar application on yield and yield components of chickpea (*Cicer arietinum* L.). Research Journal of Agriculture and Biological Sciences. Vol. 3(4): 220-223.

Anchal, D.; Kharwara, P.C.; Rana, S.S. and Dass, A. (1997). Response of gram varieties to sowing dates and phosphorus level under onfarm condition. *Himachal J. Agric. Res.,* 23: 112–5

Caliskan, S.; Ozkaya, I.; Caliskan, M.E. and Arslan, M. (2008). The effect of nitrogen and iron fertilization on growth, yield and fertilizer use efficiency of soybean in Mediterranean type soil. Field Crops Research. Vol. 108: 126-132.

Chauhan, Y.S.; Johanson, C. and Venkataratnam, N. (1992). Effect of phosphorus deficiency on phenology and yield components of short duration pigeonpea. *Trop. Agri.,* 69: 235–8.

Chemining wa, G.N. and Vessey, J.K. (2006). The abundance and efficacy of *Rhizobium leguminosarum* bv. *viciae* in cultivated soils of eastern Canadian prairie. Soil Biology & Biochemistry. Vol. 38: 294- 302.

Kar, P.C.; Patro, G.K. and Mohanty, K. (1989). Effect of fertilizer levels on the growth and yield of Bengal gram. *Curr. Res. Univ. Agri. Sci.,* 18: 80–81.

Kurdali, F. (1996). Nitrogen and phosphorus assimilation, mobilization and partitioning in rainfed chickpea (*Cicer arietinum L.).* Field Crops Research, 47:81-92.

McKenzie, B.A. and Hill, G.D. (1995). Growth and yield of two chickpea (*Cicer arietinum* L.) varieties in Canterbury, New Zealand. New Zealand Journal of Crop and Horticultural Science. Vol. 23: 467- 474.

Roy, S.K.; Rahaman, S.M.L. and Salahuddin, A.B.M. (1995). Effect of *Rhizobium* inoculation and nitrogen on nodulation, growth and seed yield of gram (*Cicer arietinum* L.). *Indian J. Agron.,* 65: 853–7.

Rudresh, D.L.; Shivaprakash, M.K. and Prasad, R.D. (2005). Effect of combined application of Rhizobium, phosphate solubilizing bacterium and Trichoderma spp. on growth, nutrient uptake and yield of chickpea (*Cicer aritenium* L.). Applied Soil Ecology. Vol. 28: 139-146.

Singh, B.G. and Hiremath, S.M. (1990). Effect of phosphate fertilization on physiological aspects of mungbean. Journal of Maharashtra Agricultural University. 15(2): 176-78.

Togay, N.; Togay, Y.; Cimrin, K.M. and Turan, M. (2008). Effect of Rhizobium inoculation, sulfur and phosphorus application on yield, yield components and nutrient uptake in chick pea (*Cicer aretinum L.*). African Journal of Biotechnology. Vol.7(6): 776- 782.

Table (1): Effect of variety, compost and DAP fertilization on chickpea grain yield and some yield components during seasons 2016/17.

Fertilizers	Plant height	No of pods/plant	N0/of branches	100-Seed weight (g)	yield/t/ha.
			Atmuor variety		
Compost	50.2	30.1	6.5	15.0	1.7
1DAP	49.0	28.4	6.0	13.0	1.6
2DAP	48.7	40	6.0	13.3	1.6
Compost+1DAP	51.2	56.4	7.1	14.9	2.1
Compost+2DAP	53.6	60.0	8.9	15.3	2.6
Control	44	23.1	5.2	11.0	1.2
SE. ±	0.510**	0.324**	0.543**	0.996**	0.231**
CV%	16.14	11	15.9	14.3	18.9
L.S.D	0.170	0.108	0.181	.332	0.770
E.S.E	0.231	0.411	0.476	0.599	0.412
			Borgeig variety		
Compost	49.6	30.1	6.0	18.0	1.5
1DAP	48.0	28.4	6.0	17.5	1.4
2DAP	48	40	6.0	17.6	1.4
Compost+1DAP	51	56.4	6.3	20.9	1.7
Compost+2DAP	53	60.0	6.9	25.4	2.2
Control	46.2	23.1	4.4	14.5	1.2
SE. ±	0.340**	0.336**	0.667**	0.460**	0.103**
CV%	18.0	12.6	17.0	13.20	21.10
L.S.D	1.20	1.01	2.0	1.4	0.214
E.S.E	0.123	0.432	0.542	0.654	0.412

*,**,*** Significant at P = 0.05, 0.01 and 0.001 respectively

Table (2): Effect of variety, compost and DAP fertilization on chickpea grain yield and some yield components during seasons 2017/ 18.

Fertilizers	p/height	No of pods/plant	N0/of branches	100-Seed weight (g)	yield/t/ha.
Atmuor variety					
Compost	51	30	5.5	16.13	1..3
1DAP	48.9	31	6.1	14.12	1.4
2DAP	49	39	7	14.16	1.6
Compost+1DAP	53	55	8	15.14	1.9
Compost+2DAP	57	59	9.6	16.17	2.8
Control	41	24	4.5	12.10	.9
SE. ±	0.789**	0.822**	0.213**	0.180**	0.630**
CV%	17.6	10.9	18.0	12.0	15.1
L.S.D	0.393	0.274	.71	0.60	0.210
E.S.E	0.123	0.432	0.542	0.432	0.312
Borgeig variety					
Compost	51.10	32	6.0	17	1.5
1DAP	50	29	5.19	16.7	1.3
2DAP	49.11	41	5.95	18	1.4
Compost+1DAP	53.20	55.8	7.1	22.12	1.9
Compost+2DAP	55.51	65.	7.86	26.40	2.4
Control	22.15	23.9	4.00	13.10	0.8
SE. ±	0.633**	0.348 **	0.669**	0.963**	0.409**
CV%	16.3	12.6	15.9	13.20	20.12
L.S.D	0.211	0.119	0.223	.321	0.153
E.S.E	0.145	0.463	0.536	0.621	0.523

*,**,*** Significant at P = 0.05, 0.01 and 0.001 respectively

Table (3): Combined analysis of the Effect of variety, compost and DAP fertilization on number of seeds/pod, 100 seeds weight and seed weight of on chickpea during seasons 2016/ 17 and 2017/ 18 at Hudeiba Research in high trace soil.

Fertilizers	No of pods/ plant			100- Seeds weight (g)			Seed yield (ton/ha)		
Compost	28c	32c	30c	15c	14d	14.5d	1.6b	1.4d	1.5d
1DAP	28c	30d	29d	15c	14d	14.5d	1.5c	1.5c	1.5d
2DAP	26d	29e	27.3e	14d	16.0c	15c	1.6b	1.5c	1.6c
Compost+1DAP	35b	37b	36b	17.3b	16.7a	17b	2.1a	1.9b	2.0b
Compost+2DAP	44a	42a	43a	18a	16.6b	17.3a	2.1a	2.3a	2.2a
Control	20e	24f	22f	11e	11e	11e	0.6d	0.8e	0.7e
Mean	30.2	32.2	31.3	15c	14.7	14.8	1.6	1.6	1.6
SE. ±		0.1			0.6			0.07	
CV%		15			4.9			19.4	

According to Duncan's Multiple Range Test (DMRT) the data had the same letter column wise were not significantly differences at $P < 0.05$ level.

Table (4): The economic evaluation of the effect of variety, Compost and DAP fertilization on number of seeds/pod, 100 seeds weight and seed weight of on chickpea during seasons 2016/17 and 2017/ 18 at Hudeiba Research in high trace soil.

Treatment	T.Y/ MT/ha.	T.V.C. SDG/ ha.	T. R. SDG/ ha.	N.R SDG/ ha.	MR	MC	MRR%
Control	0.7	12804.4	56000	43195.6	0	0	0
Compost	1.5	18992.4	120000	101007.6	57812	6188	9342.6
1DAP	1.5	17564.4	120000	102435.6	1428	D	D
2DAP	1.6	22324.4	128000	105675.6	3240	4760	68.07
Compost+1DAP	2.0	23752.4	160000	136247.6	30572	1428	2140.9
Compost+2DAP	2.2	24228.4	176000	147487.6	11240	476	2361.3

Where; T.Y = Total yield, T.V.C = Total variable cost, T.R = Total return, N.R = Net return, M.R = Marginal return, M.C = Marginal cost, MRR = Marginal rate of return.