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Research Article

Effects of Micro-Dose (NPK) Fertilizer on Yield of Subsistence Rain-Fed Crops in North Kordofan State, Sudan

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Abstract

The effects of climate change on North Kordofan state ecosystems are severe, widespread and affect food security as well as productivity; hence in the latest years the state characterized by limited rain fall situations. Therefore, efficient use of micro-dosing fertilizers seems to be of vital importance to enhance productivity of the rain-fed crops cultivated in the area. The present research was conducted during two successive rainy seasons (2014/15 - 2015/16) at two locations. The research was carried out to investigate the effect of micro- dose of NPK with control treatments on yield of pearl millet (*Pennisetum glaucum*) and cowpea (*Vigna unguiculata*). The study concerned with pearl millet yield attributes such as: number of tillers per plant, tillers weight (g), 1000-grain weight (g) and yield (ton/ha). In case of cowpea the attributes include: number of pods per plant, number of seeds per pod, 100-seeds weight (g) and seed yield (ton/ha). The experiment was laid out in a Randomized Complete Block Design (RCBD) with six replications. Data were analyzed using (ANOVA). In pearl millet, micro dose was significantly higher than control in number of tillers per plant and tillers weight found to be 24.12g in case of dose application and 17.80g in control. The results showed highly significant effect of micro-dose in pearl millet yield ($p \leq 0.05$), high micro dose recorded 3.30 ton/ha, while the control recorded 2.17 ton/ha. On the other hand cowpea produced the highest number of pod per plant under micro-dose (24.06) and (17.61) with control. The highest number of seeds per pod was demonstrated by micro-dose treatments which resulted in increased final seed yield of 2.65 ton/ha as compare to control 1.69 ton/ha. It was concluded that application of micro-dose of NPK had a significant effect in most studied attributes and shortening the maturity period. Therefore, to increase yield and yield components in the study area during rainy seasons application of micro-dose of NPK is recommended.

Keywords: Cowpea; Micro-Dose; Pearl Millet

Introduction

Agriculture and food systems must improve and ensure food security, and to do so they need to adapt to climate change and natural resource pressures and contribute to mitigating climate change. Climate change has already significantly impacted agriculture [1] and is expected to further impact directly and indirectly on food production. Traditional dry-land farming is the major production system and source of livelihood for more than 75% of the population in Western Sudan. The major food crops grown are millet and sorghum while groundnut and sesame are the major cash crops. Other crops grown are cowpea, maize, cotton, and okra. The productivity of the main crops is very low as compared to other parts of the world [2]. This is due to a magnitude of natural and socio-economic constraints. Poor crop establishment and low soil fertility are particularly constraining for crop productivity. North Kordofan State (NKS) lays in the dry zone of central Sudan between latitudes 15 - 11 and 45 - 16 north. The state is divided into four groups, namely, land Algayzan, Garduod sediment, valleys, and mud-cracked. in North Kordofan State is integral part of traditional farming, before three decades productivity was high and household used to cover all grain or cereal needs from farm production i.e. through direct access. Over the years crop production has fluctuated due to many factors such as low/erratic rainfall, pest infestation and low soil fertility. The area has experienced high environmental degradations; resulted in declined productivity and depletion of large livestock herds along with plant species which makes most of the rural people living in highly vulnerable conditions. Accordingly, the area continuously experienced food gaps or food insecurity and getting food aids. The study site, north Kordofan State, falls in the semi-arid zone where sandy soil type. The region is characterized by seasonal variation in rainfall and low soil fertility. The maintenance of soil fertility is becoming one of the most important interventions required to increase crop productivity in the dry areas.

In Sudan, pearl millet (*Pennisetum glaucum* L.) is the second most important crop after sorghum in terms of area cultivated and total production. The total area planted in the country in 2011 was about 2.4 million ha with an annual production of about 0.63 million metric tons [3], indicating an extremely low yield production. Pearl millet is the preferred staple food for the majority of inhabitants of Western Sudan (Darfur and Kordofan States). Here, pearl millet is mainly produced under rained conditions in traditional farming systems where drought is causing substantial yield reduction. In these areas, pearl millet is the most extensively grown crop, and therefore, a millet based farming system prevails. Cowpea (*Vigna unguiculata* L. Walp.) is one of the important grain legumes in the world and is playing an important role in the livelihood of millions of people in developing countries [4]. Cowpea is considered more tolerant to drought than soybean or mug bean because of its tendency to form a deep taproot. It has a competitive niche in sandy soils, does not tolerate excessively wet conditions and should not be grown on poorly drained soils. One of the most remarkable things about cowpea is that it thrives in dry environments; available cultivars produce a crop with as little as 300 mm of rain-fall. Cowpea is a most versatile African crop: it feeds people, their livestock and the next crop. The plant itself can be dried and stored until needed as fodder for livestock. As a nitrogen-fixing legume, cowpea improves soil fertility and consequently helps to increase the yields of cereal crops when grown in rotation.

Objective of the Study

The objective of the study was to evaluate the effect of applying micro-dosing of NPK on dry matter production and grain yield of pearl millet and seed yield of cowpea.

Materials and Methods

Sites of the experiments and climate

Field experiments were conducted during 2014 - 2016 rainy seasons at two locations (Faris, between longitudes 30.04° and latitude 12.78 N° and Eldomokia longitudes 30.47° and latitude 13.28° E), Sheikan locality, North Kordofan State, Sudan. These locations were chosen to represent South and the North-east sides of the locality. The state generally lies between the arid and semi-arid dry regions of the world. The average temperature varies from 6°C in winter to more than 45°C during summer periods. During autumn the humidity, temperature, wind direction and rainfall have very important role on plant growth. The rainfall is less than 50 mm/year in the North and more than 400 mm/year in the southern part of the state. The dominant types of soil in the area are sandy soils with clay pockets plus valleys in depressions [5].

Experimental design and treatments

The experiment consisted of two treatments for two crops namely pearl millet (Variety Ashana) and cowpea (Variety Einelgazal). The crops were grown on soils either by applying micro-dose of NPK at planting time or left without fertilization as control. Treatments were laid out in a randomized complete block design (RCBD) with six replications. The plot size was (5 × 3m) and the spacing was (75 × 50 cm) for pearl millet The micro dosing rates applied were 0.9g NPK about 18 - 21 fertilizer granules per hole and (50 x 30 cm) for cowpea with the addition of 0.6g of NPK (12 - 14 fertilizer granules per hole). The recommended micro-dose of NPK fertilizer was placed together with the seeds in the same planting hole [6]. Plots included four rows five meters in length for each crop. Planting was done after sufficient rainfall moisture availability in the soil on 15th July. After two weeks from planting, the plots were weeded and the plants were thinned to two per hole. The second weeding was carried out after a month from planting.

Measurement of growth and yield attributes

Growth and yield attributes measured during crop growing period and after maturity of pearl millet included number of tillers per plant, tillers weight (g), 1000-grain weight (g) and yield (ton/ha). In case of cowpea the attributes included number of pods per plant, number of seeds per pod andweight100 seeds (g).

Statistical analysis

The collected data were analyzed using single and combined analysis of variance for each location according to the procedure described by Gomez and Gomez [7] for a randomized complete block design.

Results and Discussion

Pearl millet

Table 1 showed that, applying NPK fertilizer resulted in higher number of tillers per plant as compared with control and the difference was significant at 0.05 level of significance, so NPK fertilize has better effect on number of tillers than the control. The number of tillers per plant consistently increased at the two locations during both seasons. Increased in number of tillers with an increased in nitrogen levels was obvious due to that fact, nitrogen promotes the plant growth and had positive effects on number of tillers this result in accordance with findings of Reddy., *et al*. [8] and Frank., *et al* [9].

Referring to tillers weight (Table 1), it was found when NPK fertilizer was added, the values of weight were higher the values of control in both locations and seasons and the differences between values were significant at 0.05 level. These results are in agreement with findings of Chellamuthu and Agrawal [10] who also reported significant improvement in growth parameters of pearl millet due to fertilizer application. With respect to 1000 - Grain weight (g) as demonstrated in table 2. The results showed a significant differences at 0.05 level between the treatments in the first season at Faris and in the second season at Eldomokia. But there were no significant differences in season one at Eldomokia site and in season two at Faris. It is obvious that the increase in seed weight is may be due to increase of the leaf area and number of leaves in the extra tillers. Table 2 showed that, the maximum yield of 3.77 ton/ha was recorded with NPK fertilizer in the second season at Eldomokia while the minimum yield of 1.67 ton/ha was recorded in the first season at Eldomokia and demonstrated by control. The

Treatment	No. of Tillers/plant					Tillers weight(g)				
	Faris1	Eldomokia1	Faris2	Eldomokia2	Comb	Faris1	Eldomokia1	Faris2	Eldomokia2	Comb
NPK	13.5	7.25	9.8	13.67	11.05	13.50	17.0	34.17	31.83	24.12
Control	11.0	5.50	7.2	9.83	8.38	9.25	12.5	23.3	26.17	17.80
SE+	0.46*	0.34*	0.47*	0.42*	0.18**	1.43*	0.74*	1.32*	0.54*	0.36**
C.V	7.45%	10.6%	13.6%	8.86%	9.39%	25.06%	9.98%	11.26%	4.54%	8.58%

Table 1: Effect of NPK on Number of tillers/plant and tillers weight (g) in Pearl millet grown during 2014/15 and 2015/16 rainy seasons.

Treatment	1000 - grain weight(g)					Yield(ton/ha)				
	Faris1	Eldomokia1	Faris2	Eldomokia2	Comb	Faris1	Eldomokia1	Faris2	Eldomokia2	Comb
NPK	10.98	9.43	10.85	11.42	10.67	3.73	2.12	3.60	3.77	3.30
Control	9.23	9.15	11.58	12.07	10.50	2.15	1.67	2.53	2.34	2.17
SE+	0.14*	0.67ns	0.22ns	0.08*	0.12ns	0.32**	0.04**	0.22**	0.22**	0.07**
C.V	2.71%	14.5%	4.78%	1.60%	5.71%	16.45%	3.7%	17.4%	13.42%	11.17%

Table 2: Effect of NPK on1000 - weight (g)and Grain yield (ton/ha) in Pearl millet Grown during 2014/15 and 2015/16 rainy seasons.

difference between values was found to be significant at 0.05 level. results suggested that for the high-yielding summer, a combined NPK fertilization is required to enhance grain filling and yield as concluded by Kui Liu [11] and accordance with Sharma., *et al*. [12], Maqsood., *et al*. [13] and Asghar., *et al*. [14] who concluded that grain yield of maize and cereal crops increased with application of NPK fertilizer.

Cowpea

In case of cowpea (Table 3), number of pods per plant was increased with applying NPK fertilizer. The highest pod number was 29,5 and recorded at Eldomokia location in the first season while the lowest number was 14.75 and recorded in Faris location in the first season. The combined analysis also revealed highly significant differences at 0.01 level among treatments. The results of the pod number per plant agreed with the report of Yakubu., *et al.* [15] which stated that, increasing P levels increased the number and size of nodules. Cowpea was generally recognized as being nodulated by a large range of soil rhizobia [16]. Number of nodules increased significantly with an increase in P rates - it was lowest at 0 kg P_2O_5/ha and highest at 45 kg P_2O_5/ha [17].

Table 3 showed that, the difference in values of number of seeds/pod between NPK and control was found to be significant at 0.05 level, number of seeds per pod plants from micro-dose produced more number of seeds per pod (12.83) as compared with control plots (10.25). number of seeds per pods recorded significant response to P fertilizer application as deduced by Singh., *et al*. [18], Owolade., *et al*. [19] and Rajput [20].

Table 4 showed that, effect of NPK fertilizer resulted on 100-Seeds weight (g) was not significant. This result in line with [21] who reported that there was no significant effect of N and P fertilizer application on 100- Seeds weight as reported in present study. Micro-dose of NPK significantly increased the final seed yield ton/ha, in both locations as demonstrated in table 4. The highest yield was observed in the 1st and the 2nd season at Eldomokia whereas the lowest yield was observed at Faris in control plots in both seasons. Similar results were obtained by Nyoki and Ndakidemi [22] and Sarker., *et al*. [23] who reported that, increased in grain yield of cowpea is due to inoculation.

Conclusion and Recommendations

Effect of NPK fertilizer on growth and yield attributes on millet and cow pea was studied at two different locations in North Kordofan State. Application of NPK micro doses was found to increase number and weight of tillers in millet. Millet final grain yield was increased significantly by NPK. In case of cowpea number of pods/

Treatment	No. of pod/plant					No. of Seeds/pod				
	Faris1	Eldomokia1	Faris2	Eldomokia2	Comp	Faris1	Eldomokia1	Faris2	Eldomokia2	Comb
NPK	19.25	29.50	22.50	25.0	24.06	12.25	11.75	12.50	12.83	12.33
Control	14.75	19.25	17.17	19.3	17.61	11.50	10.25	10.83	10.50	10.77
SE+	0.84*	0.96*	0.72*	.051*	0.67**	0.18*	0.35*	0.24*	0.24*	0.14**
C.V	9.90%	22.5%	8.92%	5.59%	15.95%	2.98%	6.43%	4.95%	4.95%	5.96%

Table 3: Effect of NPK on number of pods/plant and number of seeds/pod in Cowpea grown during 2014/15 and 2015/16 rainy seasons.

Treatment	100- seeds weight(g)					Seeds yield(ton/ha)				
	Faris1	Eldomokia1	Faris2	Eldomokia2	Comb	Faris1	Eldomokia1	Faris2	Eldomokia2	Comb
NPK	19.4	22.80	17.43	22.82	20.61	2.010	3.417	2.093	3.118	2.659
Control	21.5	24.28	17.90	20.32	21.00	1.505	1.955	1.418	1.915	1.698
SE+	0.46ns	0.35ns	0.15ns	0.36ns	0.13*	0.17*	0.39*	0.12*	0.08*	0.05**
C.V	4.47%	3.1%	2.13%	15.5%	3.15%	19.5%	18.8%	12.97%	7.5%	11.97%

Table 4: Effect of NPK on 100- seeds weight (g) and Seeds yield (ton/ha) in Cowpea grown during 2014/15 and 2015/16 rainy seasons.

plant, number of seeds/pod and seed yield was increased remarkably when using NPK fertilizer. To increase productivity of millet and cowpea in north kordofan State, NPK fertilizer is recommended.

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