

Response of Pearl Millet to Form and Level of Fertilizers under Irrigation

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Abstract

The objective of the trial was to determine the suitable fertilizer form and the optimum dose for pearl millet (cultivar Ashana) under irrigation. Four forms of fertilizer and five levels of each fertilizer form were assigned in a complete factorial experiment laid out in a randomized complete block design with three replications. The forms were urea (46%N), nitrophosca (18:18:5), ammonium sulphate nitrate (26%N) and ammonium sulphate (21% N), while the levels of each fertilizer form were 0N, 0.5N, 1N, 1.5N, and 2N. The experiment was carried-out at the Gezira Research Farm during 2004 and 2005. The parameters studied were: Days to 50% flowering, plant height, panicle length, panicle grain weight, grain number per panicle and per unit area, number of productive tillers, 1000 grain weight, nitrogen utilization efficiency, grain yield and threshing ability. The study showed that the form of fertilizer had no significant effect on all the variables studied, while variables like grain number per unit area, number of productive tillers and nitrogen utilization efficiency were significantly affected by levels of each fertilizer form. This in turn had resulted in a significantly more grain yield with added fertilizer levels. The study recommended that pearl millet (cultivar Ashana) could be fertilized under irrigation by any of the mentioned four forms at a level of 1N of each form. This is equivalent to kg/fed of: 40 kg urea, 100 kg nitrophosca, 70 kg ammonium sulphate nitrate and 86 kg ammonium sulphate.

Introduction

Millet is a collective term referring to a number of small-seeded annual grasses cultivated as food crops, mainly on marginal lands in dry areas, temperate, subtropical, and tropical regions (FAO and ICRISAT, 1996). The important species are pearl millet, finger millet, porso millet, and foxtail millet. Pearl millet accounts for almost half of global millet production. As the most important species of millet in terms of area and production, it contributes substantially to food security in regions of Africa and Asia that can produce little else. Finger millet is widely produced in higher altitude regions of Africa and Asia as a food crop and for traditional beer. Porso millet is important as a food crop in parts of Asia and as birdseed in developed countries while Foxtail millet is important in parts of China and Europe. Those various species differ in their physical characteristics, quality attributes, soil and climatic requirements and growth duration (Payne 1997). Developing countries, (mainly Asia and Africa) account for 94% of global output, estimated at 28 million tons. Of this, pearl millet accounts for about 15 million tons, foxtail millet for 5 million tons, porso millet for 4 million tons and finger millet for over 3 million tons. Pearl millet in particular is critically important for food security in some of the World's hottest, driest cultivated areas. Very limited quantities of millet are produced in the developed countries as birdseed and as a consequence very

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limited quantities of millet are recorded in international trade. In Sudan, pearl millet area is about 1-2 million ha, with an average grain yield of 0.2-0.4 t/ha and a total annual production of 0.2-0.6 million tons. The crop is mainly cultivated in the drier parts of Northern Kordofan and Darfour states, parts of Butana area and in limited quantities in Southern Sudan. Recently, Pearl millet gains importance under irrigation especially in striga sorghum infested areas and in parts where irrigation water is scarce and the growing season is short. As the crop water requirements are less (300 mm) compared to sorghum (400 mm) and maize (500-600 mm), it suits irrigated areas with limited water supply and is particularly important in irrigated areas where sowing date for sorghum is delayed beyond the recommended. Pearl millet cultural practices especially the form and level of fertilization under irrigation is scarce and often lacking. The objective of this study is to determine the optimum form and level among different fertilizers and to furnish information for pearl millet (cultivar Ashana) under irrigation.

Materials and Methods

The experiment was raised at the Gezira Resarch Farm during two seasons (2004 and 2005). The physical and chemical characteristics of the site were as shown by the soil and water Research Centre, ARTC 1990. The trial examined 20 treatment combinations factorially assigned in a randomised complete block design and replicated three times. The treatments were four forms of fertilizers each was applied at five levels. The fertilizers forms were urea (46:0:0), nitrophosca (18:18:5), ammonium sulphate nitrate, (26:0:0) and ammonium sulphate (21:0:0). The levels for each form of fertilizer were 0N, 0.5N, 1N, 1.5N, and 2N. The experiment was sown (cultivar Ashana) on ridges 80 cm apart, and an intra-row spacing of 20 cm during the second week of July in each season. At each season, plants were thinned at 2-3 weeks after emergence to one seedling per hill allowing maintaining an optimum plant population of 26,250 per fed. at each treatment. More than 90% of this population was maintained till harvest. Fertilization was carried at a week from thinning followed by immediate irrigation. Gross and net harvested areas were 5 rows x 5 m length x 0.8 m and 3 rows x 4 m length x 0.8 m respectively. The data collected in each season for the two seasons was: Plant height, panicle length (both were recorded from five randomly selected plants per plot), days to 50% flowering, number of productive tillers, panicle number, panicle grain number and grain number per unit area, panicle grain weight, grain yield, 1000-grain mass and crop thresh ability (ratio of grain yield to panicle weight expressed as a percent). The data in each season and for the two seasons was statistically analysed using Genestat, version 3.2. The model followed in the analysis was as described by Gomez and Gomez 1984.

Results and Discussion

The interactions of year x form, year x level, form x level and year x form x level were not significant and their data was not shown. Total rainfall in each year was presented in Table 1. The second season (2005) was more wet (267 mm) than the 2004 (163 mm).

Days to 50% flowering, plant height, panicle length, and panicle grain weight

There were no significant differences in the four parameters. Across both form and level of fertilizers, the range in the four parameters was 46 days for days to 50%

flowering, 187-192 cm for plant height, 25 cm for panicle length and about 19-21 cm for grain weight per panicle (Table 2).

Grain number per panicle and per unit area, number of productive tillers and 1000 grain mass

Both forms and levels of fertilizers had no significant effect on grain number per panicle and on 1000 grain mass, but the grain number per unit area and the number of productive tillers significantly increased with added nitrogen levels (16100-26000 for the former and 2.5-3.2 for the latter) (Table 3). Among the four forms of fertilizers, urea seemed to have a significant effect on the number of productive tillers (3.2) compared to other forms (2.7-2.9).

Nitrogen utilization efficiency, grain yield and threshing ability

Generally, the form of fertilizer had no significant effect on the three variables. As regard the level of fertilizer, nitrogen utilization efficiency was higher at low fertilizer levels and was lower at higher levels (Table 4). This was also reported by many authors (Raun W.R and Johnson G.V 1999, Maman et. al 1999). The grain yield at 1N, 1.5N and 2N was significantly greater than the grain yield at 0N and 0.5N (Table 4 and Fig. 1 and 2). The regression analysis showed that 1N was optimum level for any form of fertilizer (Figs. 3, 4, 5 and 6). There were no differences in the threshability of the crop due to levels of fertilization.

Conclusions

The form of fertilizer had affected the various parameters studied in the same way, while the level of fertilizer had significantly affected the grain number per unit area, the number of productive tillers and nitrogen utilization efficiency. This in turn resulted in a significant increase in grain yield across the nitrogen levels.

Recommendation

Pearl millet, cultivar Ashana, could be fertilized by urea (46% N), nitrophosca (18:18:5), ammonium sulphate nitrate (26% N) or ammonium sulphate (21% N) at a level of 1N of each fertilizer form. This is equivalent to kg per feddan of: 40 kg urea, 100 kg nitrophosca, 70 kg ammonium sulphate nitrate and 86 kg ammonium sulphate, and the farmer choice will depend on the market cost.

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Table 1. Rainfall (mm)

| Element | Year | July | August | September | October | Total (mm) |
|---------------|------|------|--------|-----------|---------|------------|
| Rainfall (mm) | 2004 | 41 | 100 | 11 | 11 | 163 |
| Rainfall (mm) | 2005 | 83 | 136 | 48 | Trace | 267 |

Table 2. Combined means for days to 50% flowering, plant height, panicle length and panicle grain weight.

| Treatment | Days to 50% flowering | Plant Height (cm) | Panicle length (cm) | Panicle grain wt (g) |
|-----------|-----------------------|-------------------|---------------------|----------------------|
| Urea | 46 | 191 | 25 | 20 |
| NPK | 46 | 188 | 25 | 20 |
| ASN | 46 | 190 | 25 | 20 |
| AS | 46 | 189 | 25 | 20 |
| LSD | 0.7 | 5.5 | 0.8 | 2.6 |
| 0N | 46 | 188 | 25 | 19 |
| 0.5N | 46 | 187 | 25 | 19 |
| 1N | 46 | 190 | 25 | 20 |
| 1.5N | 46 | 192 | 25 | 21 |
| 2N | 46 | 190 | 25 | 21 |
| LSD | 0.8 | 6.2 | 0.9 | 3.1 |
| CV % | 3.0 | 5.7 | 6.6 | 17.3 |

Table 3. Combined means of grain number per panicle and per unit area, number of productive tillers and thousand grain mass.

| Treatment | Grain number (PN ⁻¹) | Grain number (000) (m ⁻²) | Number of productive tillers | 1000 grain mass (g) |
|-----------|----------------------------------|---------------------------------------|------------------------------|---------------------|
| Urea | 1767 | 22.9 | 3.2 A | 11.6 |
| NPK | 1734 | 20.2 | 2.9 B | 11.5 |
| ASN | 1701 | 20.4 | 2.9 B | 11.7 |
| AS | 1701 | 19.6 | 2.7 B | 11.8 |
| LSD | 226 | 3316 | 0.2 | 0.53 |
| 0N | 1640 | 16.1 C | 2.5 D | 11.8 |
| 0.5N | 1588 | 17.8 BC | 2.8 BC | 12.0 |
| 1N | 1748 | 21.3 AB | 2.9 AB | 11.5 |
| 1.5N | 1739 | 22.7 AB | 3.2 A | 11.9 |
| 2N | 1913 | 26.0 A | 3.1 AB | 10.9 |
| LSD | 253 | 3707 | 0.25 | 0.6 |
| CV % | 26 | 31.1 | 15.1 | 8.9 |

Table 4. Combined means for nitrogen utilization efficiency (NUE), grain yield and threshing ability.

| Treatment | NUE (kg/kgN/fed) | Grain yield (kg/fed) | Threshability (%) |
|-----------|------------------|----------------------|-------------------|
| Urea | 30.6 A | 1103 | 62.1 |
| NPK | 18.4 AB | 986 | 61.7 |
| ASN | 20.1 AB | 1002 | 63.0 |
| AS | 12.2 B | 968 | 61.9 |
| LSD | 12.1 | 176 | 4.6 |
| 0N | 0 C | 801 C | 62.4 |
| 0.5N | 37.5 A | 906 BC | 59.1 |
| 1N | 23.4 B | 1026 AB | 62.5 |
| 1.5N | 23.3 B | 1147 A | 61.4 |
| 2N | 17.4 B | 1193 A | 65.4 |
| LSD | 13.5 | 196 | 5.2 |
| CV % | 11.0 | 13.7 | 14.5 |

Fig.1 grain yield as affected by levels of nitrogen

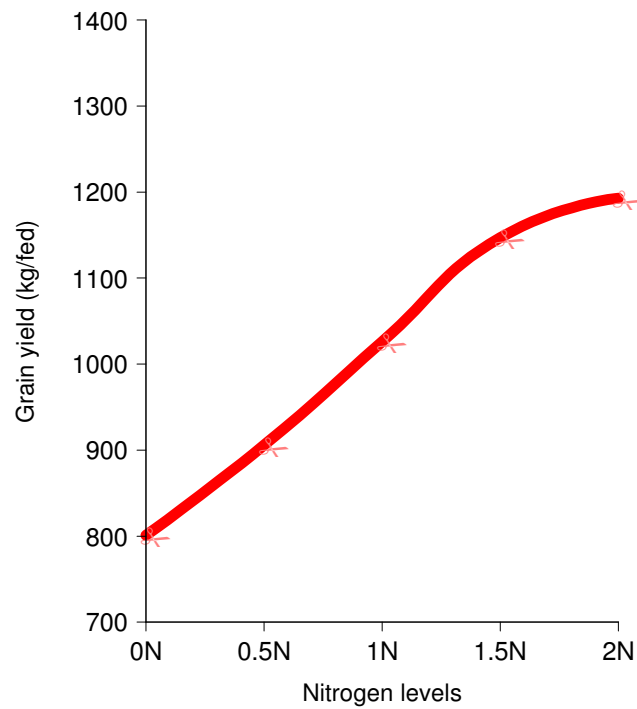


Fig.2 grain yield as affected by levels of nitrogen
 $Y = 809.6 + 5.125x$. ($R^2 = 97.7$)

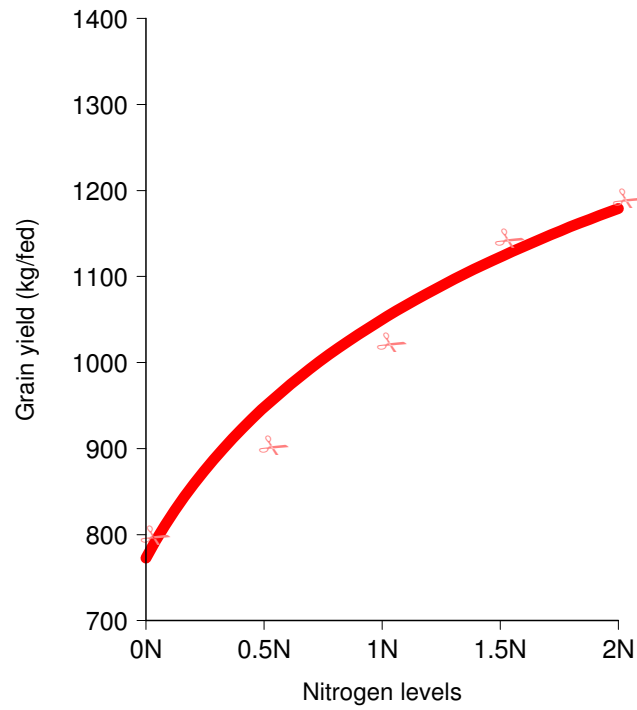


Fig.3 grain yield as affected by levels of urea
 $Y = 931.6 + 4.365x$. $R^2 = 0.70$. $SE = 5.6$.

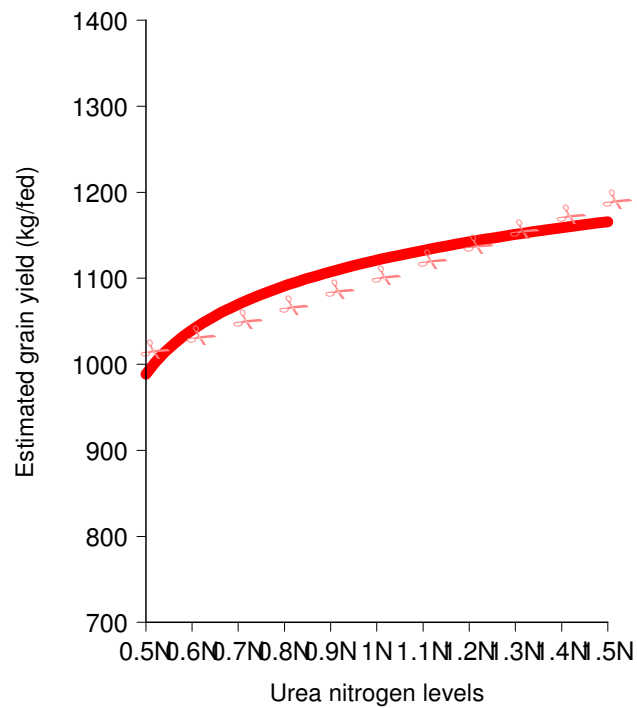


Fig.4 grain yield as affected by levels of NPK
 $Y=745.8+2.402x$. $R^2 = 0.67$. $SE= 7.9$

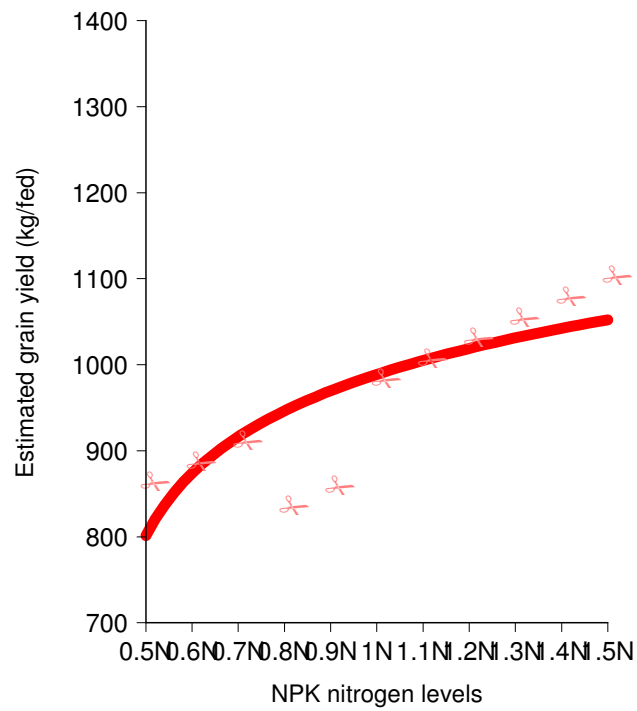


Fig.5 grain yield as affected by levels of ASN
 $Y=818.4+2.62x$. $R^2 = 0.91$. $SE= 5.9$

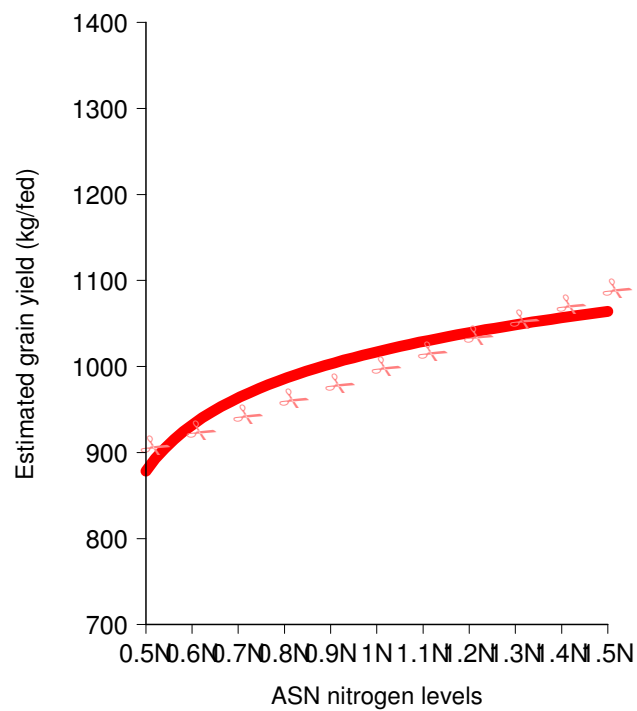


Fig.6 grain yield as affected by levels of AS
 $Y=750.0 + 2.54x$. $R^2 =0.80$. $SE= 7.3$

