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Response of A Newly Developed Fodder Sorghum (*Bicolor* L. Monech) Variety (F-9917) to NPK Application

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Abstract

Field experiments were conducted during 2007-2009 to determine a balanced nutrient management for enhanced and cost-effective production of sorghum as a fodder crop. A newly developed sorghum variety (F-9917) was grown with ten different treatment combinations of nitrogen, phosphorus and potassium applied in the form of urea, diammonium phosphate and potassium sulphate. There was a gradual increase in crude fat, crude protein and grain fodder yield with the application of fertilizers. Fertilizer application @ 80-50-25 kg ha $^{-1}$ (T7) resulted in maximum green fodder and dry matter yield during the three consecutive years. Crude fat and crude protein contents were also increased with fertilizer application. Maximum crude fat and crude protein in all three study years were obtained from the treatment of NPK application @ 80-50-25 kg ha^{-1}. The optimum and economical dose for maximum grain fodder yield of F-9917 was found to be 80 kg nitrogen, 50 kg phosphorus and 25 kg potassium per hectare.

Key words: Crude fat; Crude protein; Fodder sorghum, Fertilizer, Nutrient management

Introduction

Sorghum (*Sorghum bicolor* L.) locally known as Jawar or Chari is an important Kharif season (summer) crop which is grown both for fodder and grains. Sorghum fodder is considered one of the essential feeds for livestock if properly cured as silage with a little supplement of protein, can maintain cattle in good health conditions during the winter with little or no grain supplement. Sorghum fodder contains more than 50% digestible nutrients with 8% protein, 2.5% fat and 45% nitrogen-free extract (NFE). Its nutritional value is equivalent to that of corn that is why animals relish well due to its palatability and succulent nature (Wheeler, 1950).

The soils in Pakistan have been reported deficient in nitrogen and phosphorus whereas potassium deficiency is crop specific, hence response to N and P is universal (Anonymous, 2003). Several types and varieties of sorghum have been grown for centuries in Sub-continent, China and Africa. In Pakistan sorghum is grown on an area of 0.281 mha in 2007-08 and 0.263 mha in 2008-09 with long, taller varieties cultivated for fodder and dwarf varieties for grain purposes (Anonymous, 2009).

Fertilizers are rich source of plant nutrients required for increased crop productivity. The balanced use of fertilizers can help in providing much needed nutrients to the soil, thereby increasing crop yields and reducing damage to the environment. The insufficient and imbalanced use of fertilizers in Pakistan is one of the major causes of crop yield reduction. There are reports in the literature that balanced application of NPK increased sorghum yield up to 122 % in India (Shrotriya, 1998). Higher crop yield means maintaining the supply of organic mater and vegetative cover, thus enhancing moisture retention, nutrient use efficiency and soil productivity (Bumb and Baanante, 1996).

Kharif fodders have low nutritive value, poor ratooning ability and give poor yield. The quality and quantity of green fodder can be increased by determining its optimum fertilizer requirements. The response of different varieties might be different to fertilizer application under changing soil and environmental conditions. The present research work, thus was undertaken to evaluate the response of newly developed sorghum variety (F-9917) to different combinations of NPK fertilizers for high and quality green fodder and dry matter yields.

Materials and Methods

Three field experiments were conducted during 2007-2009 at Fodder Research Institute, Sargodha to evaluate the response of newly developed sorghum variety (F-9917) to different combinations of NPK fertilizers. The crop was sown in medium loam soil having pH 8.1, EC 2.0 dsm^{-1} and organic matter 0.69%. The available phosphorous and potassium in the soil was 7.3 mg/kg and 188 mg/kg. The experiment was laid out in RCBD with three replications. The net plot size measured 3×5 m². The crop was sown at 30cm row to row distances using single row hand drill. Eleven N-P-K combinations

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including control (T1) were applied at the time of sowing. Different fertilizer combinations rates were 00-25-25 (T2), 40-25-25 (T3), 80-25-25 (T4), 120-25-25 (T5), 80-00-25 (T6), 80-50-25 (T7), 80-75-25 (T8), 80-25-00 (T9), 80-25-50 (T10), and 80-25-75 (T11) Kg ha^{-1} . Urea, diammonium phosphate and potassium sulphate were used as fertilizer source.

The crop was harvested at 50% heading and green fodder yield (G.F.Y) was recorded. Dry matter yield was calculated after drying the plant samples in the oven at 70ºC. The oven dried samples were analyzed for crude protein and fat determinations. The crude protein content were determined by using micro kjeldahl method (Jackson, 1962). Crude fat was determined according to the approved AACC method 30-20 (AOAC, 1984). Data on these parameters were analyzed statistically at 5% level of significance (Steel and Torrie, 1984).

Results and Discussion

Fodder yield

The results showed significant differences in the green fodder yield of sorghum cultivar F-9917 during all three study years (Table 1). The maximum green fodder yield (64.18t/ha) was recorded in the year 2008 while the minimum green fodder yield (50.88t/ha) was obtained in the year 2009. Significant differences were also observed among different combinations NPK fertilizers application. It was observed that there was gradual increase in yield with N and P application. The application of NPK fertilizers at the rate of 80-50-25 kg/ha (T7) resulted in maximum grain fodder yield (76.00 t/ha, 81.33t/ha and 65.67t/ha) in all three years, respectively while the minimum grain fodder yield (39.33t/ha, 41.00t/ha and 29.33t/ha) was obtained in control treatment (T_1) in all the three years, respectively (Table 1). The low yield in the absence of NPK in T1 treatment indicates the positive contribution of these fertilizers to the overall yield of sorghum. However, the application of nitrogen fertilizers at higher rates (120 kg/ha) in T_4 treatment also lead to decrease in the green fodder yield. The optimum dose of nitrogen was found to be 80 kg/ha for this variety.

An increase in dry matter yield was observed with the application of NPK fertilizers. Significant differences were observed in dry matter yield of F-9917 in three years (Table 2). The maximum dry matter yield (14.03 t/ha) was obtained in 2008 while the minimum dry matter yield (11.40 t/ha) was obtained in 2009. There were also significant differences among fertilizer treatments for dry matter yield. The maximum dry matter yields (16.03 t/ha, 16.67 t/ha and 14.07 t/ha in 2007, 2008 and 2009, respectively) were obtained with the application of NPK fertilizers at the rate of 80-50-25 kg/ha (T7). Dry matter yield recorded from T8 treatment was found to be statistically at par with T7 treatment in 2007, 2008 and 2009 and produced dry matter yield of 15.87 t/ha, 16.50 t/ha and 13.93 t/ha, respectively while minimum dry matter yields (8.37 t/ha, 9.70 t/ha and 7.00 t/ha in 2007, 2008 and 2009 respectively) were obtained in T1 (control) treatment (Table 2). These findings suggest that integrated use of NPK fertilizers has positive effect on the dry matter yield of sorghum fodder. Significant effect of N and P application on dry matter was also reported by Malik *et al*. (1992). Zahid and Bhatti (1994) stated that N application increased dry matter. Gill *et al.* (1995) also demonstrated that P application increased dry matter in sorghum.

Table 1 Comparison of green fodder yield of F-7719 in three years

Fertilizer Levels	Grain Fodder Yield (tha^{-1})		
(N-P-K $kgha^{-1}$)	2007	2008	2009
T1 (control)	39.33j	41.00h	29.30i
T2 (00-25-25)	50.00i	54.00g	40.67h
T3 (40-25-25)	54.33h	58.33f	45.00g
T4 (80-25-25)	57.67f	59.67ef	45.67 g
T5 (120-25-25)	56.00g	61.00e	48.00f
T6 (80-00-25)	61.00e	64.67d	51.33e
T7 (80-50-25)	76.00a	81.33a	65.67a
T8 (80-75-25)	71.00b	75.67b	60.67b
T9 (80-25-00)	70.00bc	73.33c	59.33c
T10 (80-25-50)	69.33c	72.00c	59.33c
T11 (80-25-75)	64.67d	65.00d	54.67d
Mean	60.85b	64.18a	50.88c

LSD at 0.05% level of significance

Integrated use of N, P and K gives better results than a single use of nutrient element. There are reports in literature indicating positive effects of integrated use of NPK on crop yield and productivity (Medina *et al*., 1984; Zahid and Bhatti, 1994; Waheed, 1995; Bhatti *et al,*. 1996). Khan *et al.,* (2005) reported that use of different combinations of NPK fertilizers in sugarcane showed best growth and yield of crop. Tanchev (1995) also indicated that NPK fertilizers applied in different combinations improved growth and yield of sorghum. The higher yields in new variety could be accredited to positive contribution of a combination of fodder yield components like number of leaves per plant, plant height and leaf area which were improved with fertilizer application.

Fodder quality

A progressive increase was observed in crude protein and crude fat contents of F-7719 with the application of NPK fertilizers. There was significant difference in the crude protein contents in all study years. The highest crude protein (7.20 %) was obtained in the years 2008 and 2009 while lowest crude protein (6.86 %) was obtained in the year 2007 (Table 2). The variation may be due to the soil and environmental factors etc.

Table 2 Comparison of dry matter yield of F-7719 in three years

Fertilizer Levels	Dry matter yield (tha^{-1})		
(N-P-K kgha^{-1})	2007	2008	2009
T1 (control)	08.37h	09.70h	07.00h
T2 (00-25-25)	09.00g	10.83g	08.87g
T3 (40-25-25)	11.47f	12.40f	10.50f
T4 (80-25-25)	12.60e	13.67e	11.03e
T5 (120-25-25)	13.57cd	14.60cd	11.73d
T6 (80-00-25)	14.27bc	15.27b	12.37b
T7 (80-50-25)	16.03a	16.67a	14.07a
T8 (80-75-25)	15.87a	16.50a	13.93a
T9 (80-25-00)	14.07bc	15.17bc	12.13c
T10 (80-25-50)	14.60b	15.33b	12.03c
T11 (80-25-75)	12.93de	14.20de	11.73d
Mean	13.06b	14.03a	11.40c

LSD at 0.05% level of significance

Significant differences in respect of crude protein content and fat contents were observed in the response to application of NPK. In 2007, the highest crude protein (8.07%) was obtained by the application of NPK fertilizers at the rate of 80-75-25 kg/ha (T7). The NPK application at the rate of 80-75-00 kg/ha (T8) produced higher crude protein (7.93%) which were statistically at par with the T7 treatment while the minimum crude protein (5.03%) was observed in T1 (control) treatment (Table 3). The non significant difference between T7 and T8 treatments indicates that potassium merely contributes to the protein contents of the sorghum fodder.

Table 3 Comparison of crude protein of F-7719 in three years

Fertilizer Levels	Crude protein (%)		
(N-P-K kgha^{-1})	2007	2008	2009
T1 (control)	05.03h	05.80f	06.00j
T2 (00-25-25)	06.10g	06.20e	06.30i
T3 (40-25-25)	06.27g	06.60d	06.80h
T4 (80-25-25)	06.50f	06.90c	07.00g
T5 (120-25-25)	06.73e	07.10c	07.20f
T6 (80-00-25)	07.07cd	07.70b	07.50d
T7 (80-50-25)	08.07a	08.00a	07.90a
T8 (80-75-25)	07.93a	08.00a	07.90a
T9 (80-25-00)	07.70b	07.80ab	07.80b
T10 (80-25-50)	07.13c	07.70b	07.60c
T11 (80-25-75)	06.90de	07.60b	07.40e
Mean	6.86b	7.22a	7.22a

LSD at 0.05% level of significance

In 2008, the maximum crude protein (8.0%) was observed with application of NPK fertilizers at the rate of 80-50-25 kg/ha (T7) and 80-75-25 kg/ha (T8). T9 treatment (NPK @ 80-25-00) was statistically at par with T7 and T8 treatments and resulted in higher crude protein (7.8%) than other treatments. The minimum crude protein (5.8%) was observed in control treatment. In 2009, maximum crude protein (7.9%) was obtained in T7 (NPK @ 80-50-25 kg/ha) and T8 (NPK @ 80-75-25 kg/ha) while minimum crude protein (6.0%) was observed in control treatment (Table 3). The increase in protein content with N and P application is in accordance with the finding of Shinde *et al.* (1993). Patal *et al*. (1993) and Pankhaniya *et al*. (1997) also observed the increase in protein with the increasing rates of N.

The crude fat contents of sorghum also increased with the application of NPK fertilizers. Significant differences were observed in the crude fat contents of F-9917 during three years. The maximum crude fat contents (1.347%) were observed in 2008 which was found to be statistically at par with the crude fat contents (1.346%) in 2009 while the minimum crude fat (1.230%) contents were observed in 2007.

NPK fertilizer combinations were also significantly different from one another. In 2007, maximum crude fat (1.47%) contents were observed with the application of NPK fertilizers at the rate of 80-50-25 kg/ha (T7) The application of NPK fertilizers at the rate of 80-75-25 kg/ha (T8) also produced higher crude fat (1.37%) and was statistically at par with T7 treatment while minimum crude fat (1.03%) was observed in T11 treatment (NPK @ 80-25-75 kg/ha). Control (T1) and T2 (NPK @ 00-25-25 kg/ha) treatments were found to be statistically at par with T11 treatment and resulted in crude fat contents of 1.10% and 1.13% respectively (Table 4). Similarly in 2008, the highest crude fat (1.50%) was observed with the application of NPK fertilizers at the rate of 80-50-25 kg/ha Fertilizer combination (T7) which found to be statistically at par with the NPK fertilizers combinations of T8, T10, and T11 with crude fat contents of 1.45 %, 1.48 %, 1.47 %, 1.47 % and 1.45 %, respectively while the minimum crude fat (1.10%) was observed in T1 (control) treatment (Table 4).

Table 4 Comparison of crude fat of F-7719 in three years

Fertilizer Levels	Crude fat (%)		
(N-P-K kgha^{-1})	2007	2008	2009
T1 (control)	01.10fg	01.10e	01.00h
T2 (00-25-25)	01.13efg	01.11de	01.12f
T3 (40-25-25)	01.23cde	01.16d	01.30f
T4 (80-25-25)	01.27bcd	01.28c	01.35ef
T5 (120-25-25)	01.33bc	01.35b	01.37de
T6 (80-00-25)	01.20def	01.45a	01.40cde
T7 (80-50-25)	01.47a	01.50a	01.48a
T8 (80-75-25)	01.37ab	01.48a	01.46ab
T9 (80-25-00)	01.20def	01.47a	01.46ab
T10 (80-25-50)	01.20def	01.47a	01.45abc
T11 (80-25-75)	01.03g	01.45a	01.42bcd
Mean	1.230b	1.347a	1.346a

LSD at 0.05% level of significance

In 2009, maximum crude fat (1.48%) was observed with the application of NPK fertilizers at the rate of 80-50-25 kg/ha (T7). Crude fat contents in fertilizer treatments of T8, T9 and T10 were found to be statistically at par with T7 treatment and resulted in crude fat contents of 1.46%, 1.46% and 1.45%, respectively while minimum crude fat (1.0%)contents were again observed in T1.

Conclusion

The grain fodder yield and quality of sorghum variety (F-9917) increased with the application of NPK fertilizers. The increase in fodder yield with fertilizer application may be due to increase in the growth of plant. The maximum fodder yield and dry matter yield was obtained by the application of 80-50-25 kg N-P-K ha^{-1} (T7) followed by 80-75-25 kg N-P-K ha^{-1} (T8). However, the differences between T7 and T8 were non-significant for different yield and quality characteristics.

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