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On Farm Evaluation of Yield and Quality of Multicut Sorghum (*Sorghum bicolor*) Fodder Through Application of Phosphorus

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Abstract: ***This investigation was carried out in kharif 2013-14 with five levels of phosphorus fertilizer viz. 0 (T_1), 40 (T_2), 80 (T_3), 120 (T_4) and 160 (T_5) kg P_2O_5 ha^{-1} in the fields of 30 numbers of farmers. Significantly higher green fodder yield and dry matter yield were obtained at 120 kg P_2O_5 ha^{-1} in all the three cuts as well as in total green fodder yield. Total green fodder yield at 120 kg P_2O_5 ha^{-1} was increased by 35.5%, 20.6%, 14.7% and 17% over the green fodder yield at 0, 40, 80 and 160 kg P_2O_5 ha^{-1}. Significant difference in CP content was observed in 1st and 2nd cut but in 3rd cut the difference was not significant. However higher crude protein (CP) content was recorded at 120 kg P_2O_5 ha^{-1} in all the three cases. Crude fibre (CF) content was decreased significantly with the increased dose of phosphorus in all the three cuts. Effect of phosphorus on total ash (TA) content was found not significant in all the three cuts. Ether extract (EE) and Nitrogen free extract (NFE) were increased significantly with the application of phosphorus in all the three cuts. Based on the above findings it can be concluded that application of phosphorus at the rate 120 kg ha^{-1} significantly increase the green fodder yield as well as the nutritional values of sorghum.***

Keywords: Sorghum fodder, phosphorus, nutritional values, crude protein, dry matter

1. Introduction

Due to rapid and steady growth of population, demand for livestock products like meat, milk, butter and other dairy products is increasing day by day. On the other hand land for cultivation of food and forage is continuously decreasing due to rapid population explosion and urbanization. Fodder crops play a vital role in agriculture because supply of nutritious fodder in sufficient amount is a basic requirement for livestock to cater such increasing demand of livestock products for human beings. The present scenario of forage production and utilization in India is not encouraging. Availability of good quality green fodder is far less than that of requirement. As a result our cattle are left under-fed and maintained poorly. This problem is becoming more acute because of steady rise in cattle population and diversion of more areas to food crops for human consumption. Therefore, cultivation of quick growing good quality forage is urgently needed to cope up with the shortage of green forages. Fodder sorghum (*Sorghum bicolor*) is characterized by quick growth, high yield and dry matter content, leafiness and better palatability [16]. Phosphorus is one of the major plant nutrients after nitrogen and is the second most deficient plant nutrient [17]. The optimum rate of phosphorus application is important in improving the yields of most crops [4]. The yield and nutritional values of fodder varies due to many factors like soil, plant density, fertilizer dose, growing season and stage of maturity. Among them, phosphorus application is most important which directly contributes to the quality and quantity of fodder production. Application of phosphorus fertilizer gradually increase plant height, stem diameter, number of leaves per plant, leaf area and fodder yield [11]. Das *et al*., [5] observed that response of phosphorus on sorghum was strongly influenced by soil P as well as applied P level and was similar at three physiological stages viz. Boot leaf initiation, 50 percent flowering and maturity. Keeping all the above in mind, the present study was planned to assess the yield and quality attributes of sorghum fodder as influenced by different levels of phosphorus fertilizer at three cutting stages.

2. Materials and Methods

The experiment was conducted in the farmers field (30 nos.) in the villages Bamondanga and Samudrapur of North 24 Parganas district of West Bengal in eastern India during *kharif* 2013-14. The texture of the soil is loamy soil and almost neutral in nature. The experiment was carried out with five levels of phophorus fertilizer viz. 0 (T_1), 40 (T_2), 80 (T_3), 120 (T_4) and 160 (T_5) kg P_2O_5 per ha using multicut sorghum variety SSG-59-3 (meethi sudan). Doses of nitrogen and potash (K_2O) were applied at the rate of 80 kg and 35 kg per ha respectively. During final land preparation required amount of P_2O_5 (as per treatment), one-half of recommended dose of nitrogen (40 kg), full amount of potash (35 kg) were applied and rest half of nitrogen was applied 5 weeks later as top dressing. Subsequently, after 15 days after each cut, nitrogen was applied at the rate of 40 kg per ha as top dressing. Seeds of sorghum were broadcasted at the seed rate of 50 kg ha^{-1} after land preparation and fertilizer application. Plant height was measured every fortnightly. Green sorghum fodder in each plots were harvested on 65th day after sowing (1st cut), and then 2nd and 3rd cut after every 40 days. After each cut, green biomass weight was recorded and representative sample of fodder were taken. Samples were dried in sun and sieved through 40 mm mesh. Then for determining nutritional attributes of fodder, the proximate analysis as laid down by Association of Official Analytical Chemists (AOAC) was done. Data were analyzed using MSTAT programme and differences among the treatments were determined by using least significant difference test [7].

3. Results and Discussions

3.1 Green Forage and Dry Matter Yield

Application of P fertilizer had significant effect on green forage yield of sorghum in all the three cuts as well as the total yield of green forage. Similarly, Roy and Khandaker [20] also observed the significant effect of P application on total yield of green forage of sorghum influenced by increasing level of phosphorus fertilizer. Significantly, higher green forage yield of sorghum (30.11 MT ha^{-1}) was recorded at 120 kg P_2O_5 ha^{-1} and lowest (25.12 MT ha^{-1}) at T_1 *i.e* control in 1st cut [Table 1]. Similar trend was also found in 2nd cut and 3rd cut. Significantly higher total green forage yield (41.25 MT ha^{-1}) was recorded at 120 kg P_2O_5 ha^{-1} followed by that (36.35 MT ha^{-1}) of 80 kg P_2O_5 ha^{-1} and lowest total green forage yield (30.76 MT ha^{-1}) at control or no application of P fertilizer (Table 1) due to the fact that phosphorus induced higher growth in sorghum plant. Total green fodder yield at 120 kg P_2O_5 ha^{-1} was increased by 34.5%, 19.8 %, 13.9 % and 16.2 % over the green fodder yield at 0, 40, 80 and 160 kg P_2O_5 $ha^{-1.}$ Similar results were found by Sairam *et al*. [21]; Bhardwaj *et al*. [3] and Khot *et al.* [12] and they reported that green fodder yield of pangola grass was increased significantly with increased level of P fertilizer. The result of present study was also supported by the earlier observations in German grass [13] and in Napier grass [8]. Jumeno and Lozano [9] and Ram [18] also reported the similar trend and found that phosphorus in various doses increased the green fodder yield in berseem.

In all the three cuts, significant effect of P fertilizer on dry matter yield of sorghum fodder had been recorded due to the fact that phosphorus along with nitrogen plays a key role in accumulation of photosynthetases. Higher dry matter yield observed in T_4 *i.e* at 120 kg P_2O_5 ha^{-1} followed by T_3 (80 kg P_2O_5 ha^{-1}), T_5 (160 kg P_2O_5 ha^{-1}), T_2 (40 kg P_2O_5 ha^{-1}) and T_1 (0 kg P_2O_5 ha^{-1}) in all the three cuts of sorghum fodder (Table 1). Similar trend was also noted in total dry matter yield of sorghum fodder. However, dry matter per centage (on fresh weight basis) varied as 15.01-15.24 % in 1st cut, 14.15-14.78 % in 2nd cut and 12.51-13.45 % in 3rd cut (Table 1) and similar trend was also observed by Roy and Khandaker [20]. Previous experiments indicated that the application of P fertilizer increased dry matter yield of oat [15]. Similar results were also reported by Bhagwan *et al.* [2] who indicated that dry matter yield of fodder cowpea increased with the increasing levels of P fertilizer up to 60 kg TSP ha^{-1}.

3.2 NutritionalAttributes

The effect of P fertilizer application was significant for all the nutritional attributes like CP, CF, EE, total ash, NFE except dry matter per centage (Table 2 - 6) in all the three cuts. Similar results were recorded by Ayub *et al.* [1] in cluster bean. Khaleduzzaman *et al*. [10] also reported that dry matter per centage in fodder napier had not increased significantly with the increasing levels of phosphorus fertilizer application.

Significant difference in CP content was observed in 1st and 2nd cut but in 3rd cut the difference was not significant. However higher crude protein (CP) content was recorded at 120 kg P_2O_5 ha^{-1} in all the three cases (Table 2) due to the fact that phosphorus is involved in protein synthesis [14]. Roy and Khandaker [20] also reported the similar results in sorghum fodder. Crude fibre (CF) content was decreased significantly with the increased dose of phosphorus in all the three cuts (Table 3). Effect of phosphorus on total ash (TA) content was found not significant in all the three cuts (Table 5) and the similar result was also obtained by Uddin et al. [22] in oat fodder. Ether extract (EE) and Nitrogen free extract (NFE) were increased significantly with the application of phosphorus in all the three cuts. Though highest EE value was recorded at T_5 (160 kg P_2O_5 ha^{-1}) [Table 4] but significantly highest NFE was observed at T_4 (120 kg P_2O_5 ha^{-1}) in all the three cuts of sorghum (Table 6). Virender *et al.* [23] reported that EE content of berseem fodder increased significantly with increased levels of P fertilizer. Similar result was also confirmed by Islam *et al.* [8]. Average compositions of the nutritional attributes *i.e* CP, CF, EE, total ash, NFE of sorghum fodder in three cuts were depicted in fig. 1, 2 & 3.

4. Conclusion

From the current experiment it can be concluded that application of phosphorus at the rate 120 kg $P_2O_5$5 ha^{-1} significantly increase the green fodder and dry matter yield along with better quality of sorghum fodder. Phosphorus at the rate 120 kg $P_2O_5$5 ha^{-1} resulted higher crude protein and lower crude fibre percentage and thus ultimately gives better quality green forage of sorghum.

Table 1: Effect of different phosphorus levels on green fodder yield and dry matter yield of sorghum fodder at three cuts stages (Dry Matter % *i.e* g/100 g of fresh sample)

	Treatments					S.Em (±)	C.D (0.05)
	T_1	T_2	T_3	T_4	T_5		
1st Cut							
YIELD (MT/ha)							
Green Forage	25.12	26.25	27.65	30.11	27.12	0.97	2.05
Dry Matter	3.77	3.97	4.18	4.59	4.09	0.19	0.40
Dry Matter%	15.01	15.12	15.11	15.24	15.08	0.42	NS
2nd Cut							
YIELD (MT/ha)							
Green Forage	2.92	4.25	4.45	5.82	4.38	0.39	0.82
Dry Matter	0.42	0.61	0.64	0.86	0.62	0.11	0.23
Dry Matter%	14.37	14.35	14.38	14.78	14.15	0.37	NS
3rd Cut							
YIELD (MT/ha)							
Green Forage	2.72	4.05	4.25	5.42	4.12	0.37	0.78
Dry Matter	0.34	0.53	0.56	0.73	0.54	0.12	0.25
Dry Matter%	12.51	13.10	13.20	13.45	13.11	0.42	NS
TOTAL YIELD							
Green Forage(MT/ha)	30.76	34.55	36.35	41.25	35.62	1.70	3.58
Dry Matter (MT/ha)	4.53	5.11	5.38	6.11	5.25	0.35	0.74
Dry Matter %	14.73	14.79	14.80	14.81	14.74	0.45	NS

Table 2: Effect of different phosphorus levels on crude protein (CP) percentage of sorghum fodder at different cut (g / 100 g dry matter basis)

	Treatments					S.Em (±)	C.D (0.05
	T_1	T_2	T_3	T_4	T_5		
1st cut	7.17	7.21	7.20	7.79	7.20	0.22	0.47
2nd cut	7.35	7.39	7.42	7.98	7.37	0.19	0.40
3rd cut	7.41	7.57	7.62	7.81	7.59	0.23	NS

Table 3: Effect of different phosphorus levels on crude fibre (CF) percentage of sorghum fodder at different cut (g / 100 g dry matter basis)

	Treatments					S.Em (±)	C.D (0.05)
	T_1	T_2	T_3	T_4	T_5		
1st cut	36.12	35.56	35.26	34.66	34.75	0.49	1.05
2nd cut	35.15	34.75	34.52	34.00	33.92	0.52	1.10
3rd cut	35.02	34.85	34.72	33.80	33.57	0.57	1.21

Table 4: Effect of different phosphorus levels on ethyle extract (EE) percentage of sorghum fodder at different cut (g / 100 g dry matter basis)

	Treatments					S.Em (±)	C.D (0.05)
	T_1	T_2	T_3	T_4	T_5		
1st cut	2.92	3.07	3.12	3.30	3.37	0.15	0.32
2nd cut	2.87	2.96	3.03	3.03	3.27	0.14	0.29
3rd cut	2.89	3.02	3.12	3.28	3.31	0.13	0.27

Table 5: Effect of different phosphorus levels on total ash in percentage of sorghum fodder at different cut (g / 100 g dry matter basis)

	Treatments					S.Em (±)	C.D (0.05)
	T_1	T_2	T_3	T_4	T_5		
1st cut	10.47	10.18	10.45	10.03	10.70	0.26	NS
2nd cut	9.67	9.25	9.21	9.11	9.85	0.37	NS
3rd cut	10.49	10.49	10.46	9.74	10.49	0.38	NS

Table 6: Effect of different phosphorus levels on nitrogen free extract (NFE) in percentage of sorghum fodder at different cut (g / 100 g dry matter basis)

	Treatments					S.Em (±)	C.D (0.05)
	T_1	T_2	T_3	T_4	T_5		
1st cut	45.03	45.37	45.42	46.25	45.72	0.53	1.11
2nd cut	44.02	44.35	44.48	45.00	44.91	0.39	0.82
3rd cut	43.32	43.98	43.97	44.22	43.98	0.37	0.78

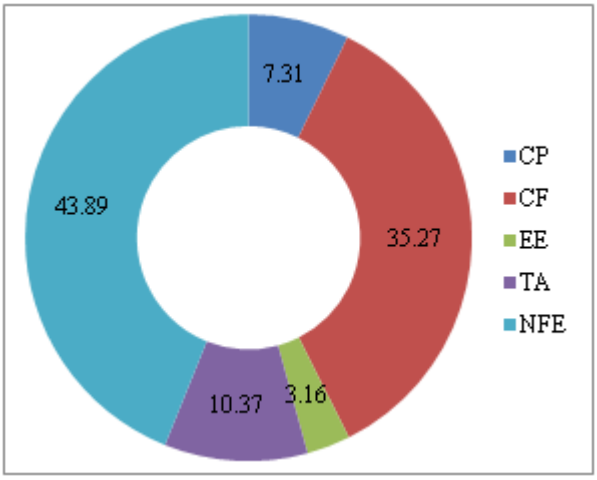

Figure 1: Average Chemical composition of sorghum fodder at first cut (in %)

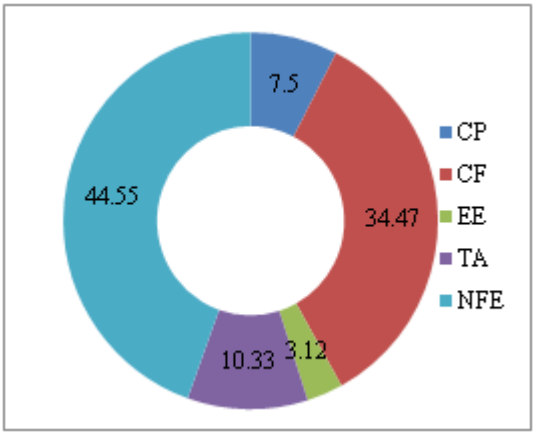

Figure 2: Average Chemical composition of sorghum fodder at second cut (in %)

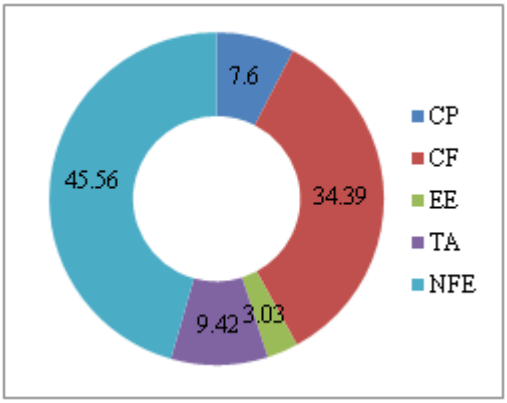

Figure 3: Average Chemical composition of sorghum fodder at third cut (in %)

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