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Effect of Nitrogen and Potassium Levels on Growth and Yield of Little Millet (*Panicum sumatrense*) under Dryland *Alfisols* of southern Karnataka

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ABSTRACT

A field experiment was carried out during Kharif -2016 at AICRP on Dryland Agriculture, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka to study the effect of nitrogen and potassium levels on growth and yield of little millet (Panicum sumatrense) under Dryland Alfisols of southern Karnataka. The experiment was conducted using Randomized complete block design with factorial concept having three nitrogen levels and four potassium levels. Application of 40 kg N ha^{-1} (686 and 1243 kg ha^{-1}, respectively) and 20 kg K_2O ha^{-1}(678 and 1221kg ha^{-1}, respectively) recorded significantly higher grain and straw yield as compared to 20 kg N ha^{-1} (529 and 1042 kg ha^{-1}, respectively) and 0 kg K_2O ha^{-1}(588 and 1116 kg ha^{-1}, respectively). Similar trends were also documented in growth attributes.

Key words: *Little millet, Nitrogen, Potassium, Yield.*

INTRODUCTION

Among minor millets, little millet (*Panicum sumatrense*) is important popular millets among the farmers of southern Karnataka known by saave or same. Because of its wider adaptability under moisture stress condition and flexibility with sowing time[4], this crop become promising and popular among the farmers of dry zone. But yield of crop is limited due to its cultivation on marginal and sub-marginal lands with imbalanced nutrition and negligence in cultivation practices. Nitrogen and potassium are the primary nutrients determine the growth and yield of crop; nitrogen is integral part of chlorophyll which ultimately manifests photosynthetic rate. Whereas, potassium is involved in enzymes activation which are necessary in many metabolic activities and translocation of photosynthates and also contributed to drought tolerance and quality improvement Presently, potassium is not recommended for little millet in southern Karnataka considering the higher K status in soil and application of organic manure, but as consequence of intensive cropping and continuous non application of potassium combined with excess application of nitrogen become serious problem in modern intensive agricultural resulted in depletion of potassium status in drylands[13,11].

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Further release of high yielding varieties demands sufficient potassium. Keeping these facts, the experiment was conducted to study the effect of nitrogen and potassium levels on growth and yield of little millet under dryland situation.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* 2016 at AICRP on Dryland Agriculture, UAS, GKVK, Bengaluru, Karnataka, India on red sandy loam soil situated in Eastern Dry Zone of Karnataka at a latitude of 12º 58´ N and longitude of 75º 35´ E with an altitude of 930 meter above mean sea level. The soil type of experimental site was red sandy loam in texture which is deep and possesses good drainage with a soil reaction of 5.36, low in organic carbon (0.36%) and available nitrogen (225.76 kg ha^{-1}), high in available phosphorus (61.54 kg ha^{-1}) and medium in available potassium (150.53 kg ha^{-1}). The field experiment was laid out in Randomized complete block design with factorial concept consisting three levels of nitrogen (N @ 20, 40 and 60 kg ha^{-1}) and four levels of potassium (K_2O @ 0, 10, 20 and 30 kg ha^{-1}) replicated thrice. The land preparation with ploughing and harrowing was carried using tractor. FYM @ 6.25 t ha^{-1} to soil 15 days prior sowing and 20 kg $P_2 O_5$ ha^{-1} was adapted commonly to all the treatments. The little millet variety JK-8 was sown at a spacing of 30×10 cm with a seed rate of 7.5 kg ha^{-1}on September 6th. The full dose of N and K was applied as per the treatment at the time of sowing in the form of urea and muriate of potash. Gap filling was done one week after sowing where seeds are failed to germinate while excess seedlings germinated were thinned at 15 DAS to maintain optimum plant population. All the crop observations were recorded adopting standard procedure. The experimental data on growth, yield and yield parameters are subjected to analysis by using Fisher's method of "Analysis of Variance " (ANOVA) as outlined by Panse and Sukhatme[8]. The level of significance was used in 'F' and 't' test was at 5 per cent.

RESULTS AND DISCUSSION

Growth and yield of little millet

Grain and straw yield in little millet was differed among the different levels of nitrogen and potassium (Table 1). Among nitrogen levels, significantly higher grain and straw yield was observed with the application of 40 kg N ha^{-1} (686 and 1243 kg ha^{-1}, respectively) as compared to 20 kg N ha^{-1} (529 and 1042 kg ha^{-1}, respectively) . But, it was statistically non-significant with application of 60 kg N ha^{-1} (703 and 1258 kg ha^{-1}, respectively). Whereas at different potassium levels, application of 20 kg K_2O ha^{-1} recorded significantly higher grain and straw yield (678 and 1221 kg ha^{-1}, respectively) as compared to 0 kg K_2O ha^{-1}. However, it was statistically on par with 30 kg K_2O ha^{-1} (675 and 1225kg ha^{-1}, respectively). Combined effect of nitrogen and potassium found statistically significant in both grain and straw yield of little millet. The application of 40 kg N + 20 kg K_2O ha^{-1} recorded higher grain and straw yield (730 and 1282 kg ha^{-1}, respectively) as compared to 20 kg N + 0 kg K_2O ha^{-1} (448 and 910 kg ha^{-1}, respectively). But, it was on par with the application of 60 kg N + 20 kg K_2O ha^{-1} (728 and 1275 kg ha^{-1}, respectively), 60 kg N + 30 kg K_2O ha^{-1} (727 and 1272 kg ha^{-1}, respectively) and 60 kg N + 10 kg K_2O ha^{-1} (692 and 1259 kg ha^{-1}, respectively).

The increased yield in this treatment was mainly due to higher yield parameters (Table 1) *viz*., number of productive tillers m^{-1} length (59.6), ear length (16.1 cm), grain weight m^{-1} length (23.4 g). These yield attributing parameters helped to get significantly higher yield. These results are in accordance with the findings of Shashidhara *et al*.[10] and Raghavendra Bhammigatti and Halikatti[9]. They indicated that synthesis, accumulation and translocation of photosynthates depend upon efficient photosynthetic structure, extent of translocation into sink (grains) and also plant growth and development during early stages of crop growth. The production and translocation of synthesized photosynthates depends upon mineral nutrition supplied.

Significantly higher yield attributing characters are directly influence for superior grain yield. Productive tiller m^{-1} length differed significantly in both nitrogen and potassium levels. Number of productive tillers m^{-1} length increased significantly from 42.9 to 56.7 with increase in nitrogen levels from 20 to 40 kg ha^{-1} and from 46.9 to 53.7 with increase in potassium from 0 to 20 kg ha^{-1}. The increase in number of productive tillers m^{-1} length is associated with increased number of tillers m^{-1} length. Grain weight m^{-1} length increased by 30 per cent in 40 kg N ha^{-1} over 20 kg N ha^{-1} and 15.30 per cent in 20 kg K_2O ha^{-1} over control, which were found statistically significant. This was mainly because of better partitioning of photosynthates to ear.

Table 1: Yield and yield parameters of little millet as influenced by different levels of nitrogen and potassium

Treatments	No of productive tillers m^{-1}	Ear length (cm)	Grain weight m^{-1} length (g)	1000 seed weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
Nitrogen levels (N)							
N_1: 20 kg ha^{-1}	42.9	11.3	16.9	2.5	529	1042	0.34
N_2: 40 kg ha^{-1}	54.2	14.6	21.9	2.5	686	1243	0.36
N_3: 60 kg ha^{-1}	56.7	15.2	22.5	2.6	703	1258	0.36
S. Em.±	0.9	0.3	0.4	0.1	12	17	0.01
CD (p=0.05)	2.5	0.7	1.1	NS	34	50	0.02
Potassium levels (K)							
K_1: 0 kg ha^{-1}	46.9	12.7	18.8	2.5	588	1116	0.34
K_2: 10 kg ha^{-1}	50.8	13.5	19.7	2.5	615	1161	0.34
K_3: 20 kg ha^{-1}	53.7	14.5	21.7	2.6	678	1221	0.36
K_4: 30 kg ha^{-1}	53.5	14.2	21.6	2.5	675	1225	0.35
S. Em.±	1.0	0.3	0.4	0.1	13	19	0.01
CD (p=0.05)	2.9	0.8	1.3	NS	39	58	NS
Interaction (N × K)							
N_1K_1	40.5	10.7	14.4	2.4	448	910	0.33
N_1K_2	40.9	10.5	15.1	2.4	471	981	0.32
N_1K_3	43.6	11.7	18.4	2.5	575	1107	0.34
N_1K_4	46.4	12.2	19.9	2.5	621	1168	0.35
N_2K_1	45.8	12.4	20.9	2.5	652	1212	0.35
N_2K_2	54.7	14.7	21.9	2.5	676	1235	0.35
N_2K_3	59.6	16.1	23.4	2.6	730	1282	0.36
N_2K_4	56.5	15.2	21.7	2.6	683	1244	0.35
N_3K_1	54.5	14.5	21.1	2.6	664	1227	0.35
N_3K_2	56.7	15.3	22.2	2.6	692	1259	0.35
N_3K_3	57.9	15.6	23.3	2.6	728	1275	0.36
N_3K_4	57.6	15.4	23.3	2.6	727	1272	0.36
S. Em.±	1.7	0.5	0.8	0.1	23	34	0.01
CD (p=0.05)	5.0	1.5	2.2	NS	68	100	NS

CD: Critical difference; NS: Non- significant

The growth parameters of little millet *viz.*, plant height, number of leaves, leaf area 0.3 m^{-1} length, number of tillers m^{-1} length and total dry matter accumulation at harvest stage were significantly differed with different levels of nitrogen and potassium (Table 2). Among different nitrogen levels, significantly higher plant height, number of leaves, leaf area 0.3 m^{-1} length, number of tillers m^{-1} length and total dry matter accumulation was recorded with application of 40 kg N ha^{-1} (40.6 cm, 17.0 $hill^{-1}$, 417 cm^2, 66.4 and 5.58 g $hill^{-1}$, respectively) as compared to 20 kg N ha^{-1} (36.6 cm, 11.0 $hill^{-1}$, 270 cm^2, 57.8 and 5.02 g $hill^{-1}$, respectively). However, it was on par with 60 kg N ha^{-1} (41.4 cm, 17.8 $hill^{-1}$, 436 cm^2, 67.7 and 5.68 g $hill^{-1}$, respectively).

Among different potassium levels, application of 20 kg K_2O ha^{-1} recorded significantly higher plant height, number of leaves, leaf area 0.3 m^{-1} length, number of tillers m^{-1} length and total dry matter accumulation (41.1 cm, 16.1 $hill^{-1}$, 397 cm^2, 66.1and 5.63 g $hill^{-1}$, respectively) as compared to 0 kg K_2O ha^{-1} (36.9 cm, 13.6 $hill^{-1}$, 333 cm^2, 60.0 and 5.06 g $hill^{-1}$, respectively). However, it was at par with the application of 30 kg K_2O ha^{-1} (40.8 cm, 16.2 $hill^{-1}$, 397 cm^2, 66.4 and 5.61 g $hill^{-1}$, respectively). Interaction effect of nitrogen and potassium found significant in all growth parameters. Application of 40 kg N + 20 kg K_2O ha^{-1} recorded significantly higher plant height, number of leaves, leaf area 0.3 m^{-1}length, number of tillers m^{-1} length and total dry matter accumulation (43.2 cm, 18.9 $hill^{-1}$, 462 cm^2, 68.8 and 5.92 g $hill^{-1}$, respectively) as compared to 20 kg N + 0 kg K_2O ha^{-1} (34.6 cm, 10.3 $hill^{-1}$, 253 cm^2, 51.9 and 4.74 g $hill^{-1}$, respectively). But, it was statistically on par with the application of 60 kg N + 20 kg K_2O ha^{-1} (42.4 cm, 18.5 $hill^{-1}$, 454 cm^2, 68.7and 5.83 g $hill^{-1}$, respectively) and 40 kg N + 30 kg K_2O ha^{-1} (42.1 cm, 18.5 $hill^{-1}$, 453 cm^2, 68.5and 5.81 g $hill^{-1}$, respectively).

Increased plant height was noticed with higher nitrogen and potassium levels due to improved meristematic activity in terms of increased cell enlargement and elongation. Greater cell elongation resulted in increased plant height. These results corroborate the findings of Chittapur *et al*.[3] and Hanumantha Rao *et al*.[6]. Significantly higher number of leaves $hill^{-1}$ was recorded in the treatment receiving 40 kg N ha^{-1} compared to 20 kg N ha^{-1}. The Increased number of leaves $hill^{-1}$ ultimately increased leaf area was evident with the data at same levels of nitrogen and potassium (Table 2) compared to all other treatments.

Table 2: Growth parameters of little millet as influenced by different levels of nitrogen and potassium

Treatments	Plant height(cm)	No. leaves $hill^{-1}$	Leaf area 0.3 m^{-1} length (cm^2)	No. tillers m^{-1} length	Total dry matter accumulation (g $hill^{-1}$)
Nitrogen levels (N)					
N_1: 20 kg ha^{-1}	36.6	11.0	270	57.8	5.02
N_2: 40 kg ha^{-1}	40.6	17.0	417	66.4	5.58
N_3: 60 kg ha^{-1}	41.4	17.8	436	67.7	5.68
S. Em.±	0.4	0.3	7	0.6	0.06
CD (p=0.05)	1.2	1.0	22	1.7	0.17
Potassium levels (K)					
K_1: 0 kg ha^{-1}	36.9	13.6	333	60.0	5.06
K_2: 10 kg ha^{-1}	39.4	15.0	370	63.4	5.41
K_3: 20 kg ha^{-1}	41.1	16.1	397	66.1	5.63
K_4: 30 kg ha^{-1}	40.8	16.2	397	66.4	5.61
S. Em.±	0.5	0.4	9	0.7	0.07
CD (p=0.05)	1.4	1.1	25	1.9	0.20
Interaction (N × K)					
N_1K_1	34.6	10.3	253	51.9	4.74
N_1K_2	35.5	10.7	261	56.2	4.86
N_1K_3	37.6	11.0	276	60.8	5.14
N_1K_4	38.9	11.8	289	62.4	5.35
N_2K_1	36.1	13.4	328	62.2	4.95
N_2K_2	41.1	17.2	425	66.1	5.63
N_2K_3	43.2	18.9	462	68.8	5.92
N_2K_4	42.1	18.5	453	68.5	5.81
N_3K_1	40.1	17.0	418	66.1	5.49
N_3K_2	41.8	17.3	424	68.0	5.73
N_3K_3	42.4	18.5	454	68.7	5.83
N_3K_4	41.5	18.4	449	68.2	5.68
S. Em.±	0.8	0.7	15	1.1	0.12
CD (p=0.05)	2.4	2.0	43	3.3	0.35

CD: Critical difference; NS: Non- significant

Increased supply of nitrogen and potassium produced robust and healthy plants, which produced more number of leaves due to reduced competition among the plants for nutrients, finally helped to realize higher leaf area (462 cm^2 0.3 m^{-1} length). To maintain higher leaf area there should be higher number of leaves which inturn depend on plant height and number of tillers. The results are in confirmative with the findings of Krishnamurthy[7]. Number of tillers m^{-1} length increased significantly with the increased levels of nitrogen and potassium at all growth stages. This was mainly due to increased vegetative growth which helped the plant to produce more number of tillers. These results are in conformity with the findings of Raghavendra Bhammigatti and Halikatti[9] and Shashidhara *et al*.[10]. Significantly higher total dry matter accumulation recorded with increased nitrogen from 20 to 40 kg ha^{-1} and potassium from 0 to 20 kg K_2O ha^{-1}. The higher total dry matter production was attributed to better plant growth which resulted in higher dry matter accumulation and better translocation to ear heads during later stages. These results are in confirmative with the findings of Shashidhara *et al*.[10].

CONCLUSION

Application of nitrogen @ 40 kg and potassium @ 20 kg ha^{-1} most optimum dose for realizing higher yield of little millet under rainfed condition.

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