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Effect of different establishment methods and potassium management practices on yield and economics of finger millet [*Eleusine coracana* (L) Gaertn]

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ABSTRACT

A field experiment was conducted at Agricultural and Horticultural Research Station, Bavikere, Tarikere Taluk, Karnataka during kharif 2016 to evaluate the effect of methods of establishment and potassium management practices on yield and economics of finger millet. The study comprised two methods of establishment (drill and transplanting), three levels of potassium application (25, 37.5 and 50 kg/ha) and two different types of application of potassium (basal and split). The results revealed that the basal application of 37.5 kg K_2O/ha under transplanted condition recorded significantly higher grain (3,583 kg/ha) and straw (6,553 kg/ha) yield. The same treatment also recorded highest net return (Rs 76,238/ha) and benefit-cost ratio (3.47) as compared to other treatment combinations.

Keywords: Potassium; establishment methods; finger millet; yield; economics

INTRODUCTION

Finger millet is an important minor millet crop grown in India and has the pride place of having highest productivity among millets. It is the staple food of the millions of the arid and semi-arid tropics of the world. In India finger millet is grown in an area of 2.25 million hectares with a production of 18.65 lakh tonnes with productivity of 1,641 kg/ha. In Karnataka finger millet is being cultivated in an area of 6.72 lakh hectares with production of 12.60 lakh tonnes and a yield of 1,715 kg/ha (Bellundagi et al 2016). The productivity of finger millet in the country as well as in the state is very low as compared to potential yield of improved genotypes. The majority of the area is under dryland situation with low to medium potassium content. Inadequate application of potassium (K) combined with an excess application of nitrogen (N) is a serious problem in modern intensive agricultural production system. Among the nutrients, potassium plays an important role in growth and development of plants. Along with nutrient management practices greater opportunities exist for increasing crop yield by adopting proper establishment methods. Hence there is a need to standardize the potassium management practices along with different establishment methods to enhance finger millet production under rainfed conditions.

MATERIAL and METHODS

The field experiment was conducted at Agricultural and Horticultural Research Station, Bavikere, Tarikere Taluk, Karnataka during 2016 under rainfed situation on deep, red, sandy loam soil to study the effect of different potassium levels and time of application on growth and yield of finger millet under drill sown and transplanted conditions. The factors comprised two methods of establishment (M_1: Drill sown and M_2: Transplanted), three levels of potassium application (K_1: 25 kg/ha, K_2: 37.5 kg/ha and K_3: 50 kg/ha) and two different type applications of potassium (T_1: 100% basal dose and T_2: 50% basal and 50% top dress). The experiment laid out in a RCBD with factorial concept was replicated three times with a gross plot size of 4.2 x 3.4 m and net plot size of 3.6 x 3.0 m. Drill sowing and transplanting were done on the same day to avoid the staggered harvesting. Fifty per cent of N and entire dose of P were applied at the time of sowing in the form of urea and di-ammonium phosphate respectively based on the nutrient combinations. The remaining 50 per cent N was top-dressed at 30 days after sowing. The potassium was supplied in the form of muriate of potash as per the treatments. The finger millet cv ML-365 was sown with a spacing of 30 × 10 cm and recommended doses of fertilizers viz 50:40:25 kg/ha of N, P_2O_5 and K_2O were applied.

The observations on growth parameters like plant height, leaf area and dry matter production were recorded at 90 DAS adopting standard procedure. Grain and straw yield was calculated based on the yield obtained from each net plot and converted to kg/ha. The cost of various inputs used and the prices of outputs in the prevailing local markets were considered for calculating economic parameters viz cost of cultivation and gross and net returns per hectare. Net return was calculated by deducting the cost of cultivation from total gross return. Benefit-cost ratio was worked as the ratio of gross return to cost of cultivation. The data were statistically analyzed by adopting procedure outlined by Gomez and Gomez (1984).

RESULTS and DISCUSSION

Establishment methods

The data revealed that the plant height, leaf area, number of tillers, total dry matter and yield were significantly influenced by different establishment methods (Table 1). Significantly highest plant height (105.87 cm), leaf area (885.59 cm^2), number of tillers/hill (4.77), total dry matter (43.58 g/plant), harvest index (0.344) and grain yield (3,300 kg/ha) were recorded with transplanting method as compared to drill sown method. The increase in number of tillers with transplanting was related to optimum plant stand, less weed competition and better root growth. Further the benefit of transplanting finger millet seedlings at a younger stage capitalizes on the fact that the early phyllochron stages have the potential to produce more tillers/plant (Nemoto and Yamazaki 1993). The establishment of finger millet seedlings and their subsequent growth depend on above-ground morphological characteristics that define seedling vigour along with growth of new roots (Hoshikawa and Ishi 1974) and the amount of irreparable damage incurred by the roots during transplanting (Ros et al 2003). The soil moisture condition was favourable at the time of transplanting due to the evenly-distributed rainfall. Hence transplanting resulted in good establishment of the crop initially. The increased growth parameters were associated with sufficient quantity of nutrients and other growth resources made available to the crop. Similar views were also expressed by Vidya (2011). The higher yield levels associated with establishment techniques can be traced back to higher values of yield attributing characters like plant height, leaf area and total dry matter of an individual plant. Similar results have been reported by Sarawale et al (2016).

Influence of levels of potassium

Application of different potassium levels also influenced the growth and yield parameters significantly (Table 1). Significantly superior plant height (89.08 cm), leaf area (920.66 cm^2), number of tillers/hill (4.98), total dry matter (45.09 g/plant), grain yield (3,467 kg/ha) and harvest index (0.350) were recorded with application of 37.5 kg K_2O/ha compared to 25 kg K_2O/ha. However it was on par with application of 50 kg K_2O/ha. Dry matter production and its accumulation in various plant parts depend upon photosynthetic capacity of plants that in turn depends on dry matter accumulation in leaves which are further influenced by total leaf area and leaf area index. All these might have been promoted by more quantity of potassium nutrients along with recommended dose of nitrogen and phosphorus made available at early stages as basal dose in finger millet crop which is very important for the initiation of leaves for its viable functionality over time for carbohydrate production and also timely cell division orienting towards increase in tallness which helps in maintaining further growth without nutrient stress. This is positive effect of potassium on yield components due to its requirement in protein synthesis and translocation of photosynthates from source to sink. Potassium is considered to be a key osmoticum in plants as it provides water relations for plants making them to survive under drought situations. Similar results of higher yield with higher dose of potassium than the recommended dose in different cropping systems was reported by Ramachandrappa et al (2014)

Time of potassium application

Along with levels of potassium application, its time of application also influenced the growth and yield parameters significantly (Table 1). significantly higher plant height (104.44 cm), leaf area (878.91 cm^2), number of tillers/hill (4.74), total dry matter (41.99 g/plant) and grain yield (3,203 kg/ha) were recorded with basal application of potassium as compared to split application. Split application of potassium failed to bring about any significant

Table 1. Effect of potassium management practices and establishment methods on growth and yield of finger millet

Treatment	Plant height (cm) at harvest	Leaf area at 90 days (cm^2)	Number of tillers/hill at harvest	Number of fingers/earhead at harvest	Total dry matter at harvest (g/plant)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index
Method of establishment								
M_1	100.65	852.68	4.56	8.49	38.69	3,000	5,989	0.332
M_2	105.87	885.59	4.77	8.89	43.58	3,300	6,270	0.344
SEm±	0.58	3.56	0.018	0.02	0.20	16.40	18.29	0.001
$CD_{0.05}$	1.71	10.46	0.054	0.07	0.58	48.12	53.67	0.002
Potassium level								
K_1	75.81	778.66	4.12	8.06	33.87	2,577	5,543	0.317
K_2	89.08	920.66	4.98	9.04	45.09	3,467	6,445	0.350
K_3	88.29	908.08	4.89	8.97	44.44	3,411	6,399	0.348
SEm±	0.28	4.37	0.023	0.03	0.24	20.09	22.40	0.001
$CD_{0.05}$	0.81	12.81	0.066	0.09	0.72	58.93	65.73	0.002
Time of application								
T_1	104.44	878.91	4.74	8.77	41.99	3,203	6,179	0.340
T_2	102.08	859.36	4.59	8.62	40.28	3,099	6,079	0.336
SEm±	0.58	3.56	0.018	0.02	0.20	16.40	18.29	0.001
$CD_{0.05}$	1.71	10.46	0.054	0.07	0.58	48.12	53.67	0.002
Method of establishment × Potassium level								
M_1K_1	89.54	753.58	3.95	7.77	30.34	2,368	5,335	0.307
M_1K_2	106.08	911.18	4.92	8.89	43.19	3,351	6,338	0.346
M_1K_3	105.92	893.27	4.80	8.80	42.54	3,293	6,293	0.344
M_2K_1	99.67	803.74	4.30	8.36	37.40	2,784	5,751	0.326
M_2K_2	109.12	930.15	5.04	9.19	46.99	3,583	6,553	0.353
M_2K_3	108.83	922.88	4.99	9.14	46.33	3,529	6,506	0.352
SEm±	1.01	6.17	0.03	0.04	0.35	28.41	31.68	0.001
$CD_{0.05}$	2.97	NS	0.09	0.12	1.01	83.35	92.95	0.003
Method of establishment × Time of application								
SEm±	0.83	5.04	0.03	0.03	0.28	23.19	25.87	0.001
$CD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS
Potassium level × Time of application								
K_1T_1	97.92	798.57	4.32	8.25	36.11	2,699	5,665	0.322
K_1T_2	91.29	758.74	3.93	7.88	31.64	2,455	5,421	0.311
K_2T_1	107.93	926.01	4.99	9.06	45.30	3,482	6,459	0.350
K_2T_2	107.67	915.31	4.96	9.03	44.88	3,452	6,432	0.349
K_3T_1	107.46	912.13	4.90	8.99	44.55	3,430	6,415	0.348
K_3T_2	107.29	904.02	4.88	8.95	44.33	3,392	6,384	0.347
SEm±	1.01	6.17	0.023	0.04	0.35	28.41	31.68	0.001
$CD_{0.05}$	2.97	18.12	0.09	0.12	1.01	83.35	92.95	0.003
Method of establishment × Potassium levels × Time of application								
SEm±	1.50	8.73	0.045	0.06	0.49	40.18	44.813	0.002
$CD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS

NS: Non-significant, M_1: Drill sown method of establishment, M_2: Transplanted method of establishment, K_1: 25 kg/ha K, K_2: 37.5 kg/ha K, K_3: 50 kg/ha K, T_1: 100% basal dose of K, T_2: 50% basal and 50% top dress dose of K difference in the grain and straw yield when compared to application of entire quantity of potassium at the time of transplanting or drilling. The rate of accumulation of potassium during the first 30 days of growth exceeded that of both nitrogen and phosphorus thereby suggesting a greater requirement for potassium than nitrogen or even phosphorus as a starter element. Similar findings were documented by Savita et al (2015) and Hossain et al (2015).

Higher basal dose of fertilizers in general and potassium in particular allowed for the efficient use of more nitrogen which resulted in production of long and wider leaves and profuse tillers that ultimately resulted in vigorous growth and greater dry matter production. In transplanted condition crop got the advantages of more and liberal nutrients and other growth resources at early stages itself due to better root growth. Transplanting along with application of 37.5 kg K_2O/ha recorded significantly higher plant height (109.12 cm), leaf area (930.15 cm^2), number of tillers/hill (5.04), total dry matter (46.99 g/plant) and grain yield (3,583 kg/ha) and it was on par with the transplanting and application of 50 kg K_2O/ha (108.83 cm, 922.88 cm^2, 4.99, 46.99 g/plant and 3,529 kg/ha respectively). The higher grain yield of finger millet in these treatment combinations could be mainly due to better translocation of photasynthates from source to sink which might have lead to better yield attributing characters.

Interaction of establishment methods and potassium management practices

Grain yield is governed by the factors which have direct and indirect impact. The factors which have direct influence on grain yield are the yield components viz number of tillers, number of earheads, number of fingers per earhead, test weight and dry matter production per plant and its accumulation into various plant parts. Among the interactions, potassium levels × time of application showed significant effect for number of earheads, number of fingers per earhead and number of tillers. Basal application of 37.5 kg K_2O/ha recorded significantly higher number of tillers/hill (4.99), number of fingers per earhead (9.06) and total dry matter (45.30 g/plant) compared to all other treatment combinations (Table 1). However it was on par with the split application of 37.5 kg K_2O/ha. The positive influence was exerted by basal application of potassium on the number of tillers, number of earheads, number of fingers per earhead and test weight of grains since it participated in the transportation of carbohydrates to the sink. Basal application of 37.5 kg K_2O/ha fertilizer recorded significantly higher grain yield, straw yield and harvest index (3,482 kg/ha, 6,459 kg/ha and 0.350 respectively) and it was on par with the split application of 37.5 kg K_2O/ha (3,452 kg/ha, 6,432 kg/ha and 0.349 respectively) followed by basal/split application of 50 kg K_2O/ha. Finger millet responded more positively to basal application of 150 per cent RDK. Due to basal application of potassium the finger millet probably might have absorbed more K at initial stages and also during growth period hence both leaf number and area were increased (Saleem et al 2010). Similar results were recorded by Ahiwale et al (2011) and Ramachandrappa et al (2014).

Economics

The data pertaining to economics (Table 2) reveal that higher gross return (Rs 1,07,051/ha) was recorded with application of 37.5 kg K_2O/ha as basal dose under transplanted condition compared to application of 25 kg K_2O/ha as split under drill sown condition (Rs 68,681/ha). It was followed by application of 37.5 kg K_2O/ha as split dose under transplanted condition (Rs 1,06,703/ha). These results are in conformity with the findings of Ramachandrappa et al (2014). Maximum net return (Rs 76,238/ha) was recorded with application of 37.5 kg K_2O/ha as basal dose under transplanted condition followed by application of 37.5 kg K_2O/ha as split in transplanted crop (Rs 75,090/ha). The higher net return was due to the higher gross return and higher yield. Highest B:C (3.47) was recorded with application of 37.50 K_2O/ha as basal dose under transplanted condition compared to all other treatment combinations. However it was followed by application of 50 kg K_2O/ha as basal dose in transplanted condition (3.40). Lower B-C ratio (2.20) was recorded with application of 25 kg K_2O/ha as split under drill sown condition. The higher B-C ratio might be due to higher gross return associated with this treatment.

CONCLUSION

The highest grain yield of finger millet under rainfed condition at southern transition zone could be achieved by adopting transplanting method along with basal application of 37.5 kg K_2O/ha. The same treatment recorded highest net return (Rs 76,238/ha) and benefit-cost ratio (3.47) as compared to other treatment combinations.

Table 2. Economics of finger millet as influenced by potassium management practices and establishment methods

Treatment combination	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
$M_1K_1T_1$	30,289	74,625	44,336	2.46
$M_1K_1T_2$	31,089	68,681	37,592	2.20
$M_1K_2T_1$	30,663	1,00,858	70,195	3.28
$M_1K_2T_2$	31,463	99,473	68,010	3.16
$M_1K_3T_1$	31,003	98,758	67,755	3.18
$M_1K_3T_2$	31,803	98,236	66,433	3.08
$M_2K_1T_1$	30,439	87,821	57,382	2.88
$M_2K_1T_2$	31,239	79,613	48,374	2.54
$M_2K_2T_1$	30,813	1,07,051	76,238	3.47
$M_2K_2T_2$	31,613	1,06,703	75,090	3.37
$M_2K_3T_1$	31,153	1,06,152	74,999	3.40
$M_2K_3T_2$	31,953	1,04,512	72,559	3.27

M_1: Drill sown method of establishment, M_2: Transplanted method of establishment, K_1: 25 kg/ha K, K_2: 37.5 kg/ha K, K_3: 50 kg/ha K, T_1: 100% basal dose of K, T_2: 50% basal and 50% top dress dose of K

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