

**EFFECT OF DIFFERENT POTASSIUM LEVELS AND TIME OF
APPLICATION ON GROWTH AND YIELD OF FINGER MILLET
UNDER DRILL SOWN AND TRANSPLANTED CONDITIONS**

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SHIVAMOGGA**

CERTIFICATE

This is to certify that the thesis entitled “EFFECT OF DIFFERENT POTASSIUM LEVELS AND TIME OF APPLICATION ON GROWTH AND YIELD OF FINGER MILLET UNDER DRILL SOWN AND TRANSPLANTED CONDITIONS” submitted in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE) in AGRONOMY** to the College of Agriculture, Shivamogga. University of Agricultural and Horticultural Sciences, Shivamogga is a bonafide record of research work carried out by **Kavyashree, N., ID NO. MA1TAE0115** (Kavyashree1021@gmail.com) during the period of study in this university under my guidance and supervision and no part of this thesis has previously formed the basis for the award of any other degree, diploma, associateship, fellowship, or any other similar titles.

**Shivamogga
July, 2017**





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(Kavyashree, N.)

Effect of Different Potassium Levels and Time of Application on Growth and Yield of Finger Millet under Drill Sown and Transplanted Conditions

(KAVYASHREE, N.)


ABSTRACT


A field experiment was conducted at Agricultural and Horticultural Research Station, Bavikere, UAHS, Shivamogga 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 during *Kharif* 2016. The experiment was laid out in RCBD factorial concept with three replications. There were 12 treatments comprising of two methods of establishment (drill and transplanted), three levels of potassium application (25, 37.5 and 50 kg ha⁻¹) and two different times of application of potassium (basal and split).

Among the methods of establishment, transplanting method recorded significantly taller plants (105.87 cm), total dry matter accumulation (43.58 g plant⁻¹), number of ear heads (4.28 hill⁻¹), test weight (3.19 g), grain yield (3,300 kg ha⁻¹) and straw yield (6,270 kg ha⁻¹) compared to drill sown method. Application of K₂O @ 37.5 kg ha⁻¹ recorded significantly taller plants (107.80 cm), total dry matter accumulation (45.09 g), number of ear heads (4.43 hill⁻¹), test weight (3.21 g), grain yield (3,467 kg ha⁻¹) and straw yield (6,445 kg ha⁻¹) as compared to other levels of potassium. Basal application of potassium recorded significantly higher plant height (104.44 cm), total dry matter accumulation (41.99 g plant⁻¹), number of ear heads (4.21 hill⁻¹), test weight (3.11 g), grain (3,203 kg ha⁻¹) and straw yield (6,179 kg ha⁻¹) compared to split application.

Among the combinations, basal application of 37.5 kg K₂O ha⁻¹ at the time of transplanting was recorded maximum grain yield (3,589 kg ha⁻¹), straw yield (6,559 kg ha⁻¹), nutrient uptake (94.15, 34.39 and 71.95 NPK kg ha⁻¹, respectively), gross returns (Rs. 10,7051 ha⁻¹), net returns (Rs. 76,238 ha⁻¹) and benefit cost ratio (3.47) and hence found feasible.

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ಕೂರಿಗೆ ಮತ್ತು ನಾಟಿ ಪದ್ಧತಿಗಳಲ್ಲಿ ವಿವಿಧ ಪ್ರಮಾಣ ಮತ್ತು ಸಮಯದಲ್ಲಿ ಪೂಟ್ಯಾಷಿಯಂ ಬಳಕೆಯಿಂದ ರಾಗಿ ಬೆಳವಣಿಗೆ ಮತ್ತು ಇಳುವರಿ ಮೇಲಾಗುವ ಪರಿಣಾಮದ ಅಧ್ಯಯನ

(ಕಾವ್ಯಶ್ರೀ, ಎನ್.)

ಸಾರಾಂಶ

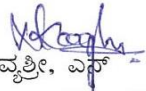
೨೦೧೬ರ ಮುಂಗಾರಿನ ಹಂಗಾಮಿನಲ್ಲಿ ಕೂರಿಗೆ ಮತ್ತು ನಾಟಿ ಪದ್ಧತಿಗಳಲ್ಲಿ ವಿವಿಧ ಪ್ರಮಾಣ ಮತ್ತು ಸಮಯದಲ್ಲಿ ಪೂಟ್ಯಾಷಿಯಂ ಬಳಕೆಯಿಂದ ರಾಗಿ ಬೆಳವಣಿಗೆ ಮತ್ತು ಇಳುವರಿ ಕುರಿತು ಅಧ್ಯಯನವನ್ನು ಕುರಿತು ಕೃಷಿ ಮತ್ತು ತೋಟಗಾರಿಕೆ ಸಂಶೋಧನಾ ಕೇಂದ್ರ, ಬಾವಿಕೆರೆ ಆವರಣದಲ್ಲಿ, ಕ್ಷೇತ್ರ ಪ್ರಯೋಗವನ್ನು ತೆಗೆದುಕೊಳ್ಳಲಾಯಿತು. ಮೂರು ಪುನರಾವೃತ್ತಿಯೊಂದಿಗೆ ಅನಿರ್ದಿಷ್ಟ ತಾಕು ವಿನ್ಯಾಸ ಪೂರ್ಣಗೊಳಿಸುವಿಕೆಯನ್ನು ವಿಭಜಿಸುವಿಕೆಯಲ್ಲಿ ಪ್ರಯೋಗವನ್ನು ಕೈಗೊಳ್ಳಲಾಯಿತು. ೧೨ ಉಪಚಾರಗಳನ್ನು ಒಳಗೊಂಡ ಎರಡು ವಿಧಾನಗಳನ್ನು (ಕೂರಿಗೆ ಮತ್ತು ನಾಟಿ ಪದ್ಧತಿ), ಮೂರು ಪ್ರಮಾಣಗಳಲ್ಲಿ ಪೂಟ್ಯಾಷಿಯಂ (೨೫, ೩೭.೫ ಮತ್ತು ೫೦ ಕೆ.ಜಿ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ಮತ್ತು ಎರಡು ವಿವಿಧ ಸಮಯಕ್ಕೆ ಪೂಟ್ಯಾಷಿಯಂ ಹಾಕಲಾಯಿತು (ಮೂಲ ಮತ್ತು ಕಂತು)

ನಾಟಿ ವಿಧಾನವು ಕೂರಿಗೆ ಬಿತ್ತನೆಗಿಂತ ಗಣನೀಯವಾಗಿ ಹೆಚ್ಚಿನ ಸಸ್ಯದ ಎತ್ತರ (೧೦೫.೮೭ ಸೆ.ಮೀ.), ಒಟ್ಟು ಒಣ ವಸ್ತುವಿನ ಕ್ರೋಢೀಕರಣ (೭೩.೫೮ ಗ್ರಾಂ ಪ್ರತಿ ಸಸ್ಯ), ಒಟ್ಟು ತೆನೆಗಳು (೪.೨೮ ಪ್ರತಿ ಸಸ್ಯ), ೧೦೦೦ ಕಾಳಿನ ತೂಕ (೩.೧೯ ಗ್ರಾಂ), ಧಾನ್ಯದ ಇಳುವರಿ (೩೩೦೦ ಕೆ.ಜಿ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ಮತ್ತು ಒಣ ಹುಲ್ಲಿನ ಇಳುವರಿಯನ್ನು (೬೨೭೦ ಕೆ.ಜಿ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ದಾಖಲಿಸಿದೆ. ವಿವಿಧ ಪ್ರಮಾಣದ ಪೂಟ್ಯಾಷಿಯಂ ನಡುವೆ, ೨೫, ೫೦ ಕೆ.ಜಿ ಪೂಟ್ಯಾಷಿಯಂ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ ಬಳಕೆ ಮಾಡಲಾದ ಉಪಚಾರಗಳಿಗೆ ಹೋಲಿಸಿದಾಗ ೩೭.೫ ಕೆ.ಜಿ ಪೂಟ್ಯಾಷಿಯಂ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ ಬಳಕೆ ಮಾಡಲಾದ ಉಪಚಾರದಲ್ಲಿ ಗಣನೀಯವಾಗಿ ಹೆಚ್ಚಿನ ಸಸ್ಯದ ಎತ್ತರ (೧೦೭.೮೦ ಸೆ.ಮೀ.) ಒಟ್ಟು ಒಣ ವಸ್ತುವಿನ ಕ್ರೋಢೀಕರಣ (೪೫.೦೯ ಗ್ರಾಂ ಪ್ರತಿ ಸಸ್ಯ), ಒಟ್ಟು ತೆನೆಗಳು (೪.೪೩ ಪ್ರತಿ ಸಸ್ಯ), ೧೦೦೦ ಧಾನ್ಯಗಳ ತೂಕ (೩.೨೧ ಗ್ರಾಂ), ಧಾನ್ಯದ ಇಳುವರಿ (೩೪೬೭ ಕೆ.ಜಿ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ಮತ್ತು ಹುಲ್ಲಿನ ಇಳುವರಿ (೬೪೪೫ ಕೆ.ಜಿ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ಬಂದಿರುತ್ತದೆ. ಕಂತುವಿನಲ್ಲಿ ಹಾಕಿದ ಪೂಟ್ಯಾಷಿಯಂಗೆ ಹೋಲಿಸಿದಾಗ ಮೂಲ ಗೊಬ್ಬರವಾಗಿ ಪೂಟ್ಯಾಷಿಯಂ ಹಾಕಿದಾಗ ಗಣನೀಯವಾಗಿ ಹೆಚ್ಚಿನ ಸಸ್ಯದ ಎತ್ತರ (೧೦೪.೪೪ ಸೆ.ಮೀ.) ಒಟ್ಟು ಒಣ ವಸ್ತುವಿನ ಕ್ರೋಢೀಕರಣ (೪೧.೯೯ ಗ್ರಾಂ ಪ್ರತಿ ಸಸ್ಯ), ಒಟ್ಟು ತೆನೆಗಳು (೪.೨೧ ಪ್ರತಿ ಸಸ್ಯ), ೧೦೦೦ ಕಾಳಿನ ತೂಕ (೩.೧೧ ಗ್ರಾಂ), ಕಾಳಿನ ಇಳುವರಿ (೩೨೦೩ ಕೆ.ಜಿ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ಮತ್ತು ಒಣ ಹುಲ್ಲಿನ ಇಳುವರಿ (೬೧೭೯ ಕೆ.ಜಿ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ಅಧ್ಯಯನದಿಂದ ಕಂಡುಬಂದಿದೆ.

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INTRODUCTION

I INTRODUCTION

Finger millet [*Eleusine coracana* (L.) Gaertn.] is an important minor millet crop grown in India and has the pride place of having highest productivity among millets. It ranks third in importance among millets with respect to area (2 million ha) and production (1.98 million tonnes) after sorghum and pearl millet in the country. In India, it is grown in an area of 12.25 lakh hectares with a production of 18.65 lakh tonnes and productivity of 1641 kg ha⁻¹. In Karnataka, finger millet is being cultivated in an area of 6.72 lakh hectares, production of 12.60 lakh tonnes with a yield of 1715 kg ha⁻¹ (Veerabhadrapa *et al.*, 2016). Finger millet is an important dry land crop due to its resilience and ability to withstand aberrant weather conditions and generally grown in soils having poor water supplying capacity and nutrients.

Finger millet is the staple food of the millions of the arid and semi arid tropics of the world. The major finger millet growing states are Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Jharkhand, Maharashtra, Telangana and Uttaranchal. It is the main dietary component in southern Karnataka particularly in districts of Bangalore, Tumkur, Mysore, Hassan, Mandya and Chitradurga dry land regions. Further, finger millet is also an ideal food for patients suffering from diabetes. The grains are rich in calcium and iron besides rich in carbohydrates. It also ensures nutritional security in most parts of semi arid tropics of India. The grains of finger millet being nutritionally superior to rice and wheat, provide cheap proteins, minerals and vitamins to the poorest of the poor where the need for such ingredients is maximum. Ragi plays a vital role of providing quality nutrition to human race. The protein of ragi is considered to be “biologically complete”. The protein content of finger millet possesses a fairly high biological value, which is needed for the maintenance of nitrogen equilibrium of the body.

The productivity of finger millet in the country and as well as state is very low as compared to potential yield of improved genotypes. The main reasons for low productivity is due to an imbalance in nutrients coupled with adverse climatic conditions, late transplanting, faulty methods of cultivation and little or no use of fertilizers. The secret of boosting its yields mainly lies in suitable planting method and properly fertilizing the crop. Proper sowing method is one of the important nonmonetary inputs in crop production, which affects the crop growth, yield and quality to greater extent. Method of establishment play an important role to exploit all available resources for growth as it provides optimum growing condition. Transplanting is an economically and environmentally ideal alternative to seeding.

The majority of the area is under dryland situation with soils having low to medium in potassium. Inadequate application of potassium (K) combined with an excess application of nitrogen (N) is a serious problem in modern intensive agricultural production systems. Among the nutrients, Potassium plays an important

role in growth and development of plants. It activates enzymes, maintains cell turgor, enhances photosynthesis, reduces respiration, helps in transport of sugars and starches, also helps in nitrogen uptake and is essential for protein synthesis. In addition to plant metabolism, potassium enhances crop quality. It helps in grain filling and grain weight, strengthens straw, increases disease resistance and helps the plant better to withstand stress.

As a consequence of intensive mono-cropping in the rainfed areas, potassium at the rate of 25 kg ha⁻¹ has been advocated to finger millet in the later years (Anon., 2006). Further, with the release of improved high yielding varieties of finger millet, the current recommendation is found to be inadequate. Potassium application has been neglected in many developing countries, including India, which has resulted in soil K depletion further declining crop yields (Regmi, 2002; Ladha, 2003; Panaullah, 2006; Lal, 2007). Most often, though levels applied are not in balanced condition as per the crop requirement. Therefore, fertilizer recommendations aim at providing balanced nutrition to crops in order to produce maximum yield.

Time of fertilizer application may considerably influence crop response to fertilizer. A number of factors like nature of the crop, its growth stages and nutrient requirements or crop needs, soil conditions, nature of fertilizer, etc., affect the time of fertilizer application. Hence, the application of fertilizer should consider the nutrient availability from soil such that nutrients are supplied in adequate quantity and in balanced amounts to plants so that desired yield target can be achieved.

Keeping these points in view, a field experiment entitled “effect of different potassium levels and time of application on growth and yield of finger millet under drill sown and transplanted conditions” was conducted at Agricultural and Horticultural Research Station (AHRS), Bavikere, Tarikere taluk, University of Agricultural and Horticultural Sciences, Navile, Shivamogga under rainfed conditions during *Kharif* 2016, with the following objectives.

1. To assess the potassium levels and its times of application under drill sown and transplanted condition
2. To study the interaction effect of methods of establishment, potassium levels and times of application of potassium on productivity
3. To study the potassium uptake pattern in drill sown and transplanted ragi

REVIEW OF LITERATURE

II REVIEW OF LITRATURE

The literature pertaining to “Effect of different potassium levels and time of application on growth and yield of finger millet under drill sown and transplanted conditions” is given in this chapter under the following headings.

2.1 Effect of establishment method o.n finger millet / cereal crops

2.2 Effect of potassium levels on finger millet/ cereal crops

2.3 Effect of time of application of potassium on finger millet/ cereals

2.4 Uptake of NPK as influenced by K application

2.5 Combined effect of method of establishment and potassium management practices on finger millet /cereals

2.1 Effect of establishment method on finger millet / cereal crops

Ehsanullah *et al.* (1998) studied that the yield and yield components such as plant height, number of panicle bearing tillers m^{-2} , normal kernels, 1000-grain weight; grain yield and harvest index was affected significantly with various planting methods. Transplanting produced significantly higher grain yield ($3.23 t ha^{-1}$) than direct seeding.

Upadhyay *et al.* (1998) reported that transplanting performed better than drilling when the crop was sown during the first fortnight of March. However, transplanting was not advisable under early-sown crop, i.e. sowing on 15 February. Delay in sowing reduced the grain yield. The age of seedling had no significant influence on grain yield.

Padhi *et al.* (2010) revealed that Application of P and transplanting finger millet significantly recorded maximum finger millet grain yield (2.20 and $2.25 t ha^{-1}$, respectively) , FMGEY ($4.46 t ha^{-1}$ and $4.45 t ha^{-1}$), net profit (₹ 15606 and ₹ $15025 ha^{-1}$), B:C ratio (1.88 and 1.82), energy output (91.2 and $90.0 MJ/kg \times 1000$) and energy- use efficiency for economic (316 and $313 g/MJ$) and biological produce (620 and $623 g/ MJ$).

Ahiwale *et al.* (2011) reported that transplanting method of crop establishment produced maximum and significantly higher grain yield ($22.40 q ha^{-1}$) and straw yield ($33.16 q ha^{-1}$) over rest of the establishment methods.

Hussain *et al.* (2013) stated that productive tillers ($315 m^{-2}$) in line transplanting and conventional planting in puddle soil were higher as compared with the remaining planting methods.

Qazi Mehmood Ali (2013) reported that the highest plant height ($111.67 cm$), productive tillers ($337.67 m^2$), panicle count ($330.67 m^2$), root length ($17.12 cm$), seed index ($27.27 g$), straw yield ($14.40 t ha^{-1}$) and cost benefit ratio ($1:1.82$) were recorded in line transplanting technique in rice crop.

Poorna Teja *et al.* (2014) revealed that yield attributes of transplanted ragi viz., number of ear heads m^{-2} , number of fingers earhead⁻¹ and number of filled grains finger⁻¹ were recorded higher with 75 per cent RDN + 25 per cent N through vermicompost (T4).

Saad *et al.* (2014) reported that total duration, number of tillers m^{-2} and plant heights were the highest under transplanting method as compared to drilling method in rice.

Adikant Pradhan *et al.* (2015) confirmed that manual transplanted finger millet being statistically on par with seed drill sown finger millet with brown manuring, showed significantly higher values of growth and yield attributes. Manual transplanted finger millet with brown manuring resulted in 10.71, 3.51 and 7.14 per cent higher grain yield over seed drill sown finger millet, conventional practice and manual transplanted finger millet without brown manuring respectively.

2.2 Effect of potassium levels on finger millet/ cereal crops

Application of potassium @ 120 kg ha^{-1} recorded significantly higher grain yield and test weight. However, the highest dry matter production was observed with 80 kg K_2O ha^{-1} (Sharif and Hussain, 1993).

The growth and yield of grain and straw of drill sown early, medium and late rice genotypes increased significantly up to the fertilizer level of 100:50:50 Kg N:P₂O₅:K₂O ha^{-1} (Upadhyay, 1994).

Thippeswamy (1995) reported that grain and straw yield of ragi increased when 50 kg K_2O was applied in three splits and the increase in yield was attributed to availability of K at critical stages of plant growth.

Raju *et al.* (1999) reported that rice yield and its attributing characters responded favourably to higher dose (60 kg K_2O ha^{-1}) of K, but not at lower doses (40 kg K_2O ha^{-1})

Iftikhar Hussain (2002) reported that different K levels significantly affected plant height, Number of fertile tillers, 1000-grain weight, grain yield and grain protein content of wheat. The highest grain yield (4.99 t ha^{-1}) was recorded in Inqulab-91 with the application of 75 kg K ha^{-1} .

In a long-term field experiment in medium black calcareous soils, the yields of finger millet and maize crops increased with 100 kg K_2O ha^{-1} . The response, however, was more prominent for maize (Santhy *et al.*, 2003).

Reddy *et al.* (2004) revealed that biomass and grain yield were increased with increased level of fertilizer application up to 60 kg ha^{-1} N, 60 kg ha^{-1} P, 40:30 kg ha^{-1} N & P in field experiments and NPK even up to 160 : 80 : 80 kg ha^{-1} in pot experiment.

Singh (2006) conducted an experiment in a silt loam soil to evaluate the effect of potassium and potassium levels on growth, yields and quality of hybrid rice. They reported that 80 kg K₂O ha⁻¹ was found better to obtain higher production and good quality of hybrid rice.

Gurkirpal Singh *et al.* (2006) in a field experiment at Ludhiana (Punjab) observed higher length of fingers (13.9 cm) and seed yield (4567 kg ha⁻¹) of finger millet with combined application of K (60 kg ha⁻¹) and zinc (25 kg ha⁻¹).

Gurumurthy *et al.* (2007) studied the effect of different levels of K on dry matter yield and uptake efficiency of K by different FCV tobacco varieties grown in southern transition zone of Karnataka and concluded that the variety Thrupthi (KST-19) recorded significantly higher dry matter accumulation followed by variety Bhavya. The potassium uptake by Thrupthi variety was also highest among the four varieties studied. The potassium uptake efficiency tended to decrease with increased potassium supply.

Muhammad Tahir (2008) stated that the application of 30, 60, 90 kg K₂O ha⁻¹ on two wheat cultivars gave highest grain yield of 4368 kg ha⁻¹ in the crop fertilized at the rate of 90 K kg ha⁻¹.

Mahfuza *et al.* (2008) in rice crop revealed that application of 60 kg K₂O ha⁻¹ in three splits resulted in significantly higher plant height (140.34 cm), number of tillers (18.65), and thousand grain weight (20.48 g)

Ashok singh *et al.* (2009) in a pot culture experiment obtained 14.7, 29.1 and 30.6 percent higher yield with application of 25, 50 and 100 kg K ppm, respectively over control.

Kacha *et al.* (2010) reported that potential production and profit from pearl millet cultivar GHB-538 could be secured by fertilizing the crop with 120 kg K₂O along with 30 kg Zn SO₄ ha⁻¹ in the medium black calcareous soil of South Saurashtra Agro-climatic region.

Ghulam Abbas (2013) confirmed that maximum numbers of grains per spike (47) were recorded at 93 kg ha⁻¹ followed by (45.13) grains per spike where potash was applied @ 124 kg ha⁻¹.

Bhanu prasad reddy *et al.* (2014) reported that significantly highest grain and straw yields were obtained with T₇ (100 kg N ha⁻¹ + 30 kg P₂O₅ ha⁻¹ + 40 kg K₂O ha⁻¹) which were on par with T₄ (100 kg N ha⁻¹ + 30 kg P₂O₅ ha⁻¹ + 20 kg K₂O ha⁻¹). The lowest grain and straw yields were obtained with control (T₁). The maximum value of harvest index was noticed with T₄ (100 kg N ha⁻¹ + 30 kg P₂O₅ ha⁻¹ + 20 kg K₂O ha⁻¹) while minimum was observed with T₁ (control).

Nigade and More (2014) stated that, on Entisols of sub-montane zone of Maharashtra, application of recommended dose of chemical fertilizers (60:30 NK kg ha⁻¹) recorded the highest grain and biological yield (2.92 and 4.07 t ha⁻¹) and B: C ratio (1.34).

Ramachandrappa *et al.* (2014) reported that application of 150% of recommended K (37.5 kg ha⁻¹) to finger millet significantly increased the grain yields (3,857 kg ha⁻¹) and straw yields (8,125 kg ha⁻¹), as compared to the grain and straw yields obtained with the recommended K (25 kg ha⁻¹) application (3,380 and 7,651 kg ha⁻¹, respectively).

Srinivasarao *et al.* (2014) stated that the balanced nutrient management in cereal production systems, K nutrition needs urgent attention in the K deficient *Alfisol* region of southern India. Addition of any amount of organic manures available at field level offers an alternative strategy for maintaining soil K fertility to improve and sustain crop productivity.

Akbar Hossain *et al.* (2015) revealed that grain and biomass yields increased gradually as K₂O level increased up to 72 kg ha⁻¹ for both the basal and split application. Yield did not increase even when the dose of K₂O was increased from 72 to 96 kg K₂O ha⁻¹. A similar trend was observed in the number of spikes m⁻², number of grains spike⁻¹ and 1000-grain weight. Therefore, 72 kg K₂O ha⁻¹ is recommended for wheat production in light soil.

The above literature on potassium nutrition clearly indicates that growth and yield of finger millet could be improved with increase in the dose of potassium application.

2.3 Effect of time of application of potassium on finger millet/ cereals

Ravi and Rao (1992) conducted a field experiment to study the effect of graded levels of potassium and times of application, with three levels of potassium (0, 60 and 120 Kg ha⁻¹) and four schedules of application (All basal, half as basal + half at 30 DAT, half as basal + half at PI stage and 1/3 equally as basal, at 30 DAT and at PI stage). They observed that dry matter productions significantly increased at 90 DAT and at harvest due to levels of potassium only.

Channabasappa *et al.* (1996) revealed that various combination of split application of P and K failed to bring about any significant difference in the grain and straw yield as well as yield components of paddy. When compare to application of entire quantum of phosphorous and potassium at the transplanting.

Pal *et al.* (2000) reported that significant differences were recorded in K uptake by rice grain due to splitting of K levels over basal and these follow the same trend as in the case of rice yield.

Manzoor *et al.* (2008) observed that maximum yield and yield components of plant height (126.62 cm), tillers per hill (20.22), panicle length (28.74 cm), No. of grains per panicle (103.80), 1000 grains weight (20.91 gm) and paddy yield (3.34 t ha⁻¹) were obtained in treatment receiving split use of Potash as ½ at 25 DAT and ½ at 45 DAT and also the efficient potash uptake by rice plant results in better growth and development when applied at maximum tillering stage (25 DAT) and at panicle initiation stage (45 DAT).

Prabhavathi *et al.* (2008) studied the influence of sources and levels of potassium on quality attributes and nutrient composition of red chillies and reported that application of potassium @ 150 per cent RDK through Sulphate of potash in 2 split doses recorded higher ascorbic acid content (175.16 mg 100 g⁻¹), colour value (225.28 ASTA units) and oleoresin content (16.79 per cent).

Saleem *et al.* (2010) reported that the highest maize grain yield of 8014 kg ha⁻¹ was recorded with application of 120 hg K₂O ha⁻¹ in three equal splits when compared to control treatment.

Ravichandran and Sriramachandrasekharan (2011) revealed that the response of rice to applied K on a Vertisol at Raipur, showed application of 40 kg K₂O ha⁻¹ in two splits as basal and at panicle initiation stage of rice significantly increased the grain yield. Potassium application 50 per cent at transplanting and 50 per cent at panicle initiation along with N is recommended in Malanad where light textured soils and high rainfall conditions are prevalent.

Srinivasa (2013) in maize crop noticed significantly higher plant height (174.4 cm), number of leaves (13.3) at 60 DAS and higher cob length (16.5 cm) with application of 125 percent RDK in two splits under sandy loam soil.

Ramachandrappa *et al.* (2014) revealed that under light texture soil application of 150 percent of recommended K (37.5 kg ha⁻¹) to finger millet significantly increased the grain yield (3,857 kg ha⁻¹) and straw yield (8,125 hg ha⁻¹) as compared to the yields obtained with the recommended K (25 kg ha⁻¹). However, application of same amount of potassium in two splits resulted in less grain yield (3599 kg ha⁻¹) and straw yield (7769 kg ha⁻¹).

Wani *et al.* (2014) revealed that split application of potassium at the rate of 80 kg K₂O ha⁻¹ was found superior to single basal application in terms of grain yield of wheat (43.20 q ha⁻¹) and K uptake (22.89 kg ha⁻¹) by grains at harvest. However, it was on par with the split application of 60 kg K₂O ha⁻¹.

Asif Iqbal *et al.* (2015) reported from their study that application of potassium at 90 kg ha⁻¹ in two splits recorded significantly higher ear dry matter (134.8 g plant⁻¹), biomass yield (11503 kg ha⁻¹) and harvest index (38.3%).

Savitha *et al.* (2015) reported that the application of Recommended N, P₂O₅ + 150% of Recommended K₂O as basal dose recorded significantly higher grain yield of finger millet as compare to control which recorded a grain yield of 2297 kg ha⁻¹.

2.4 Uptake of NPK as influenced by K application

Nutrient uptake is a function of nutrient concentration in plants and the dry matter production.

Panda *et al.* (1999) reported that application of K₂O at 40 Kg ha⁻¹ recorded significantly higher N, P and K uptake over control. The additional increase in N, P and K uptake over control was 1, 0.4 and 2.21 Kg, respectively.

Thippeswamy and Shivakumar (2000) studied that the treatments included 3 levels of K₂O *viz.*, 25 kg (K₁), 50 kg (K₂) and 75 kg (K₃) ha⁻¹ through muriate of potash applied in 4 different splits: full basal (S₁), half basal and half at tillering (S₂), half basal and quarter each at tillering and panicle initiation (S₃), and half at tillering and half at panicle initiation (S₄), with one treatment receiving no potassium (K₀). N and K uptake increased with increasing levels of K application. The N: K ratio decreased due to K application at all stages of crop growth. Basal application of K (S₁, S₂ and S₃) resulted in the lowest ratio and the highest was recorded at the tillering stage with no basal application of K (S₄). The ratio was relatively high in grain compared with straw.

Roy *et al.* (2001) revealed that combined application of N and P at different spacing levels did not show any significant results on straw yield. Uptake of N, P and K by grain and straw was also significantly increased with the increase in N, P and K. The higher dose of nitrogen at the rate of 60 kg ha⁻¹ at wider spacing of 25 cm x 10 cm increased NPK content in grain and straw than the same dose at closer spacing of 25 cm x 6 cm of finger millet.

Harikrishna *et al.* (2005) reported that the treatment receiving 200 per cent recommended nitrogen registered significantly higher uptake of NPK over 100 per cent and was on par with 150 per cent of RDF. Similarly, Yadav *et al.* (2005) reported that the NPK uptake in wheat was higher with 100 per cent NPK through fertilizers.

Ullah *et al.* (2005) reported that the effect of varying nitrogen dose and plant row spacing on the nutrient uptake pattern of foxtail millet. At maturity, irrespective of the treatment differences, the highest value of K uptake was seen in the plant tissue under 90 kg ha⁻¹ (stem-76.7298, leaf-33.773 and ear-31.849 mg plant⁻¹) and at 45 cm spacing (stem-78.195, leaf-31.15 and ear-30.695 mg plant⁻¹). Whereas, significantly highest K uptake ha⁻¹ was observed in the tissue under heavy nitrogen dose when grown at 15 cm spacing (stem-33.248, leaf⁻¹ 14.424 and 112.110 kg ha⁻¹).

Abdullahil *et al.* (2006) opined that the higher levels of K (156 kg ha⁻¹ and 312 kg ha⁻¹) improved the dry matter production in different plant parts. Yield and yield contributing characters of wheat were also improved due to high level of K application irrespective of the levels of soil moisture. The uptake of N, P and K was also enhanced with the increasing levels of K especially under water stress condition.

Gurumurthy *et al.* (2007) studied the effect of different levels of K on dry matter yield and uptake efficiency of K by different FCV tobacco varieties grown in southern transition zone of Karnataka and concluded that the variety Thrupthi (KST-19) recorded significantly higher dry matter accumulation followed by variety Bhavya. The potassium uptake by Thrupthi variety was also highest among the four varieties studied. The potassium uptake efficiency tended to decrease with increased potassium supply.

Jagathjothi *et al.* (2010) revealed that the nutrient uptake was the highest with broadcasting of enriched farm yard manure (enriched FYM) 4 t ha⁻¹ + 100 percent of recommended N and K for nitrogen, phosphorus and potassium with values of 64, 20.9 and 55.5 kg ha⁻¹ respectively.

Vidya *et al.* (2011) studied that the potassium uptake was significantly influenced by cultivars and levels but not due to time of potassium application and their interaction. The highest potassium uptake was recorded with hybrid PA-6444 at all the crop growth periods. Application of potassium @ 80 kg K₂O ha⁻¹ significantly increased the potassium uptake over control.

Brar *et al.* (2012) revealed that application of 90 kg K₂O ha⁻¹ resulted in higher N (50.9 kg ha⁻¹) and K (26.8 kg ha⁻¹) uptake by maize crop. The same treatment has recorded 19.3 percent higher nitrogen use efficiency and 28.1 percent higher apparent nitrogen recovery as compared to control.

Arulmozhiselvan *et al.* (2013) confirmed that the yield and available nutrients were higher under 150 per cent NPK which was significantly higher than 100 per cent NPK. Non-inclusion of PK in N alone treatment resulted in decline in crop productivity and available nutrient status. Uptake of NPK by both grain and straw and soil available NPK and organic carbon were also significantly higher.

Studies conducted at Indian Institute of Soil Science to compare the nutrient uptake pattern of rainy season crops such as maize, soybean, sorghum, pearl millet, finger millet and rice revealed that the highest K concentration was found in maize (3.40 %) followed by soybean (2.02 %), and rice (1.87 %) which is significantly differ from pearl millet (1.46 %), sorghum (1.44%) and finger millet (1.31 %). In case of roots, highest K content was in maize (2.46%), followed by sorghum (1.24 %), soybean (1.21 %), finger millet (1.20 %), pearl millet (1.16 %) and rice (0.62 %), respectively. (Dotaniya and Kushwah 2013).

Shruthi *et al.* (2014) reported that the growth and yield of finger millet crop was significantly higher in treatment 100 per cent NPK (POP) + FYM + P and K solubilizer (T₃). Nutrient content and uptake (major, secondary and micro nutrients) by finger millet crop was also higher in same treatment (T₃).

Dwivedi *et al.* (2016) revealed that the maximum values of N, P and K uptake by kodo grain were 28.14, 3.09 and 3.03 kg ha⁻¹ in T₁₀ (50 % NP + 100 % K + *Azotobacter* + PSB + FYM) which was significantly superior over control (T₁ – 5.90, 0.64 and 0.59 kg ha⁻¹). The increasing rates of fertilizers increased the uptake by crop in grain, which could be due to increased nutrient supply to crop.

Pallavi *et al.* (2016) stated that the nutrient content and uptake (K) by grain and straw were significantly higher with 100 per cent RDF + 25 per cent NPK poultry manure on par with sole crop compared to other nutrient combinations and control.

Naveen *et al.* (2016) reported that soil application of T₄ [125 % RDN (Recommended Dose of Nitrogen) + RDPK (Recommended Dose of PK) + FYM], recorded maximum yield (29.56 q ha⁻¹) as compared to other treatments. The maximum NPK uptake was observed in T₄ (125 % RDN + RDPK + FYM) application irrespective of fertility gradient strips and was followed by the treatment T₆ (150 % RDN + RDPK + FYM).

2.5 Combined effect of methods of establishment and potassium management practices on finger millet/ cereals

Velayutham *et al.* (1992) reported that the split application of potassium increased the NPK uptake and the yield of low land rice. The uptake of potassium and grain yield was found to be maximum under the treatments receiving K₂O @ 125 Kg ha⁻¹ for three equal splits at basal, maximum tillering and panicle primordial initiation stages.

Ravi and Rao (1992) conducted a field experiment to study the effect of graded levels of potassium and times of application with three levels of potassium (0, 60 and 120 Kg ha⁻¹) and four schedules of applications (all basal, half as basal + half at 30 DAT, half as basal + half at PI stage and 1/3 equally as basal, at 30 DAT and at PI stage). They reported that maximum test weight, number of filled grains per panicle and yield were obtained due to application of potassium in two equal splits as basal and at PI stage.

Upadhyay (1994) reported that N, P and K content and uptake in both grain and straw were not appreciably influenced due to various levels of potash. P uptake (52.8 kg ha⁻¹) by rice crop increased significantly up to 25 kg K₂O ha⁻¹ over control.

Bellakki *et al.* (1997) observed that increase in recommended dose of fertilizer level from 50 to 125 per cent resulted in increase of N uptake from 42.00 to 71.51 kg ha⁻¹ by grain and from 29.49 to 50.77 kg ha⁻¹ by straw during *Kharif* 1992-93. Similarly uptake of P and K was also increased significantly up to 125 per cent NPK dose over control.

Panda *et al.* (1999) reported that application of K₂O at 40 kg ha⁻¹ recorded significantly higher uptake of N, P and K over control. The additional increase in N, P and K uptake over control was 1, 0.4 and 2.21 kg, respectively.

Mohammad Akbar *et al.* (2010) reported that the interaction of Mg x K in terms of plant height, number of fingers per pot, grain yield and straw yield of finger millet indicated significant positive effect of potassium at all levels of magnesium. Interactions were of similar trend even in respect of uptake of Ca, Mg and K nutrients.

Vidya *et al.* (2011) revealed that application of 80 kg K₂O ha⁻¹ and its split application recorded higher performance of growth, yield attributes, yield, net returns and returns per rupee investment.

The interaction between potassium treatments involving rates and times of application had significant effect on chlorophyll content, dry matter m⁻², panicle numbers m⁻². Potassium applied as a basal at the rate of 24 kg K₂O /fad + 2 per cent spray at 60 days after transplanting (approximately at booting stage) gave the highest values of LAI, Dry matter production, chlorophyll content, panicle characteristics and grain yield (Hagras *et al.*, 2012).

MATERIAL AND METHODS

III MATERIAL AND METHODS

A field experiment was conducted to study the “Effect of different potassium levels and time of application on growth and yield of finger millet [*Eleusine coracana* (L.) Gaertn.] under drill sown and transplanted conditions” at Agricultural and Horticultural Research Station(AHRS), Bavikere, Tarikere taluk, University of Agricultural and Horticultural Sciences, Shivamogga under rainfed conditions during *Kharif* 2016. The details of materials used, procedure followed and methods adopted during the course of investigation are presented in this chapter.

3.1 Location of the experimental site

Experimental site is located at AHRS, Bavikere, which is situated at 75° 51' E longitude and 13° 42' N latitude with an altitude of 695 meters above the mean sea level. It lies in the Southern Transition Zone (STZ-VII) of Karnataka.

3.2 Soil properties of the experimental site

A composite soil sample was drawn from the experimental site before start of the experiment. The soil was air dried, powdered and passed through 2 mm sieve and was analyzed for physical and chemical properties. The results of the analysis are given in the Table 3.1.

3.3 Climatic conditions

The normal weather data for ten years and the actual climatic conditions that prevail during the crop growth period (August to November 2016) and the deviations from the normal with respect to rainfall, maximum and minimum temperature and mean relative humidity are presented in Table 3.2

3.3.1 Normal climatic conditions of the research station

The normal annual rainfall of the Bavikere station was 1037.30 mm. The major portion of rain fall was received during May to November with highest rain fall in the months of august (257.3 mm) followed by September (175.1 mm). The mean monthly maximum temperature was highest during August (38.8 °C), while it was lowest in the month of (27.6 °C). The mean minimum temperature was highest in the month of September (21.4 °C) and lowest in the month of December (17.9 °C). The maximum relative humidity was observed in the months of August (80 %) and minimum during December (65 %).

Table 3.1: Soil physical and chemical properties of experimental site

A. Physical composition			
Particulars	Values	Method adopted	
Sand (%)	62.55	Boyucos hydrometer method (Piper, 1966)	
Silt (%)	16.78		
Clay (%)	18.89		
Texture (%)	Red sandy loam		
Chemical composition			
Particulars	Values	Status	Method adopted
pH (1:2.5)	5.56	Acidic	Potential metric method (Piper, 1966)
Electrical conductivity ($d\text{ Sm}^{-1}$)	0.067	Normal	Conductivity bridge Method (Jackson, 1973)
OC (%)	0.40	Low	Wet oxidation method (Walkley and Black, 1934)
Avail N (kg ha^{-1})	156.80	Low	Alkaline permanganate Method (Subbiah and Asija, 1956)
Avail P_2O_5 (kg ha^{-1})	33.9	Medium	Brays's method (Jackson, 1973)
Avail K_2O (kg ha^{-1})	163	Medium	Neutral normal ammoniumacetate method (Jackson, 1973)



Plate 3.1: General view of experimental plot

3.3.2 Actual climatic conditions during the crop growth period of experimentation

During 2016, the rainfall received was maximum in the month of August (134.53 mm) during crop growth period. The monthly maximum temperature was recorded highest in the month of November (27.59 °C) and lowest in the month of August (26.39 °C). Monthly minimum temperature was recorded highest in the month of August (22.06 °C) and less during November (17.91 °C). Relative humidity was maximum in the month of August (89.86 %) which was 20.60 per cent higher than normal. The sunshine hours are higher in the month of October and November (7.2 and 8.7 hrs, respectively). The overall weather conditions prevailed during cropping season was normal.

3.4 Previous crop of the experiment

The maize crop was taken up during *Kharif* 2015 before taking up investigation.

3.5 Experimental details

A field experiment was conducted during *Kharif* 2016 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 and details are given below.

3.5.1 Crop details

Crop	:	Finger millet
Spacing	:	30 cm x 10 cm
Location	:	AHRS, Bavikere
Design	:	RCBD with factorial concept
Variety	:	ML-365
Gross plot size:		4.2 m x 3.4 m
Net plot size	:	3.6 m x 3.0 m
RDF	:	50:40:25 NPK kg ha ⁻¹
FYM	:	7.5 tonnes ha ⁻¹
Replications	:	3

3.5.2 Treatment details

Factor A	:	Method of establishment
M ₁	:	Drill sowing
M ₂	:	Transplanting
Factor B	:	Potassium levels
K ₁	:	25 kg ha ⁻¹ (Recommended dose)
K ₂	:	37.5 kg ha ⁻¹
K ₃	:	50 kg ha ⁻¹

- Factor C : Time of application
- T₁ : 100 per cent basal at sowing
- T₂ : 50 per cent basal + 50 per cent top dressing 6-7 week after sowing.

Treatment combinations:

- T1 : M₁K₁T₁ : Drill sown + 25kg ha⁻¹ of potassium + 100 per cent basal dose
- T2 : M₁K₁T₂ : Drill sown + 25kg ha⁻¹ of potassium + 50 per cent basal and 50 per cent top dress
- T3 : M₁K₂T₁ : Drill sown + 37.5kg ha⁻¹ of potassium + 100 per cent basal dose
- T4 : M₁K₂T₂ : Drill sown + 37.5kg ha⁻¹ of potassium + 50 per cent basal and 50 per cent top dress
- T5 : M₁K₃T₁ : Drill sown + 50kg ha⁻¹ of potassium + 100 per cent basal dose
- T6 : M₁K₃T₂ : Drill sown + 50kg ha⁻¹ of potassium + 50 per cent basal and 50 per cent top dress
- T7 : M₂K₁T₁ : Transplanted + 25kg ha⁻¹ of potassium + 100 per cent basal dose
- T8 : M₂K₁T₂ : Transplanted + 25kg ha⁻¹ of potassium + 50 per cent basal and 50 per cent top dress
- T9 : M₂K₂T₁ : Transplanted + 37.5kg ha⁻¹ of potassium + 100 per cent basal dose top dress
- T10 : M₂K₂T₂ : Transplanted + 37.5kg ha⁻¹ of potassium + 50 per cent basal and 50 per cent top dress
- T11 : M₂K₃T₁ : Transplanted + 50kg ha⁻¹ of potassium + 100 per cent basal dose
- T12 : M₂K₃T₂ : Transplanted + 50kg ha⁻¹ of potassium + 50 per cent basal and 50 per cent top dress
- FYM @ 7.5 tonnes ha⁻¹, N and P applied as per recommended dose of fertilizer

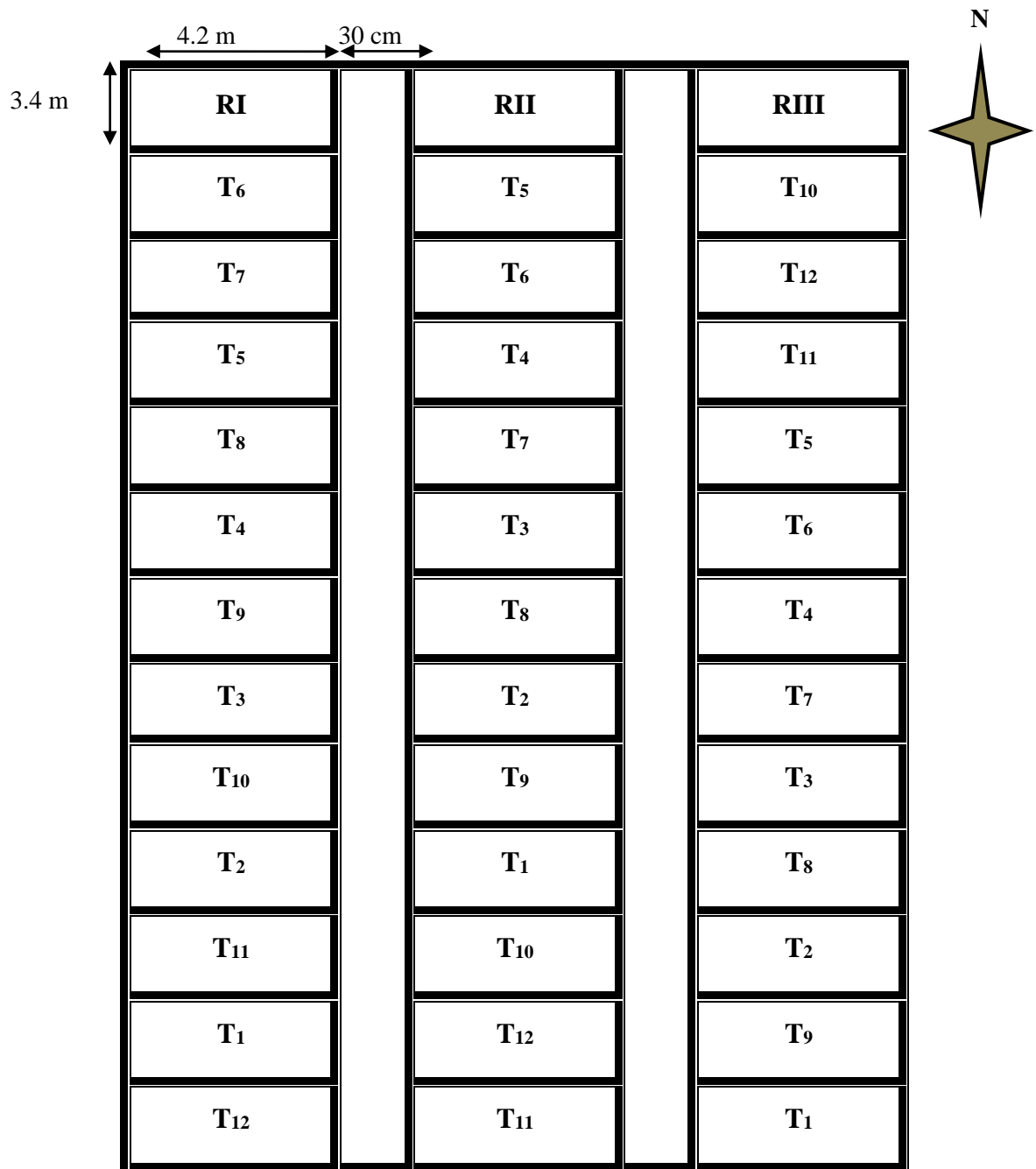


Fig. 3.1: Plan of layout of the experiment

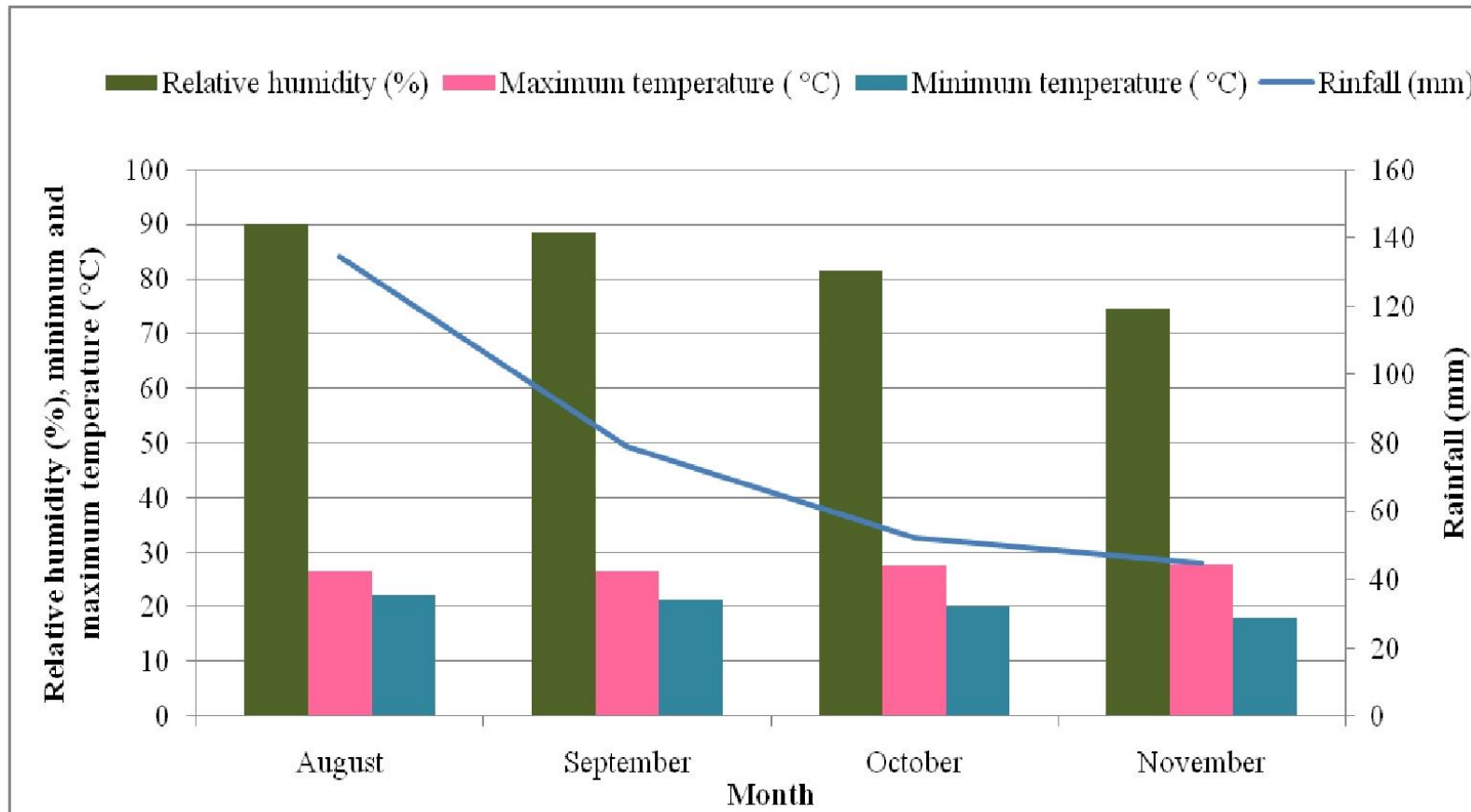


Fig. 3.2: Monthly meteorological data for the cropping period 2016 of AHRS, Bavikere, Shivamogga

Table 3.2: Monthly mean meteorological data for the cropping period (2016) and average of 10 years recorded at the meteorological observatory, AHRS, Bhavikere, University of Agricultural and Horticultural Sciences, Shivamogga.

Months	Rainfall (mm)		Monthly maximum Temperature (°C)		Monthly minimum Temperature (°C)		Relative humidity at 07:17 hours (%)		Sunshine hour	
	Normal	2016	Normal	2016	Normal	2016	Normal	2016	Normal	2016
August	257.1	134.53	38.8	26.39	21.0	22.06	80.0	89.86	4.9	4.7
September	175.2	79.19	31.7	26.48	21.4	21.21	77.0	88.52	4.8	4.0
October	118.9	52.13	30.7	27.59	20.2	19.94	75.0	81.40	6.4	7.2
November	154.4	44.93	29.8	27.81	19.5	17.91	69.0	74.49	7.3	8.7
December	--	0.0	20.1	--	17.9	--	65.0	76.1	7.0	--

Table 3.3: Date of Sowing and Harvest

Season	<i>Kharif</i> 2016
Date of sowing in field and nursery	02-08-2016
Date of transplanting	24-08-2016
Date of harvest	24-11-2016

Table 3.4: Nutrient content of FYM used in the investigation

Particulars	Nutrient concentration (%)
Nitrogen (%)	0.52
Phosphorus (%)	0.21
Potassium (%)	0.58

3.6 Cultivation practices

3.6.1 Land preparation

Land was ploughed twice with mould board plough and leveled with harrow. The land was further demarcated with small bunds to prepare the required plot size. Farm yard manure was applied @ 7.5 t ha⁻¹ was applied and mixed in to soil 15 days prior, after application place were leveled.

3.6.2 Imposition of Treatments

Organic materials such as FYM at 7.5 t ha⁻¹ was incorporated into the respective plots, two weeks before transplanting and drill sowing of finger millet crop. Drill sowing and nursery sowing is done on the same day to avoid the staggered harvesting. At the time of transplanting and drill sowing 50 per cent of the recommended dose of nitrogen and full dose of phosphorus were applied as basal dose in the form of urea and DAP according to the all treatments. . The remaining 50 per cent N was top dressed at 35 DAS and 30 DAT. The potassium was applied in two equal splits in the form of muriate of potash as per the treatments.

3.6.3 Varietal description

Finger millet cultivar used in the investigation was ML-365. It is high yielding, drought tolerant and neck blast resistant variety was developed by the Department of Genetics and Plant Breeding, University of Agricultural Sciences, Bangalore during 2008. This variety suits well under rainfed situation and can tolerate severe stress for long periods without reduction in grain yields. The variety was developed by crossing IE1012 x Indaf-5(Ril).

3.6.4 Nursery Technique

The raised nursery beds of dimension 3m x 1m x 0.1m were prepared for raising the finger millet seedlings. Seeds of finger millet were sown on 02-08-2016, in lines of 10 cm apart in the raised bed. For each bed 500 g MOP, one kg SSP and 500 g ammonium sulphate was applied to the raised beds. After 12 days of sowing, 250g urea was applied as top dress. Nursery beds were watered regularly as and when required to raise healthy seedlings.

3.6.5 Transplanting

Healthy and uniform seedlings of 22 days old were transplanted essentially in the main field at 30 cm x 10 cm spacing. Transplanting of finger millet was done in 24-08-2016. Two seedlings were maintained per hill.

3.6.6 Drill sowing

Drill sowing was also done on 02-08-2016 in the selected respective plots of main field with 30 cm x 10 cm spacing. Thinning was followed to maintain the plant population on par with the transplanting.

3.6.7 Weeding

Two hand weeding were carried out in order to keep the plots free from weed competition and there by soil moisture and nutrient losses are minimized.

3.6.8 Harvesting and Threshing

The crop was harvested after crop attained physiological maturity is 110 days after transplanting/ drill sowing on 24-11-2016 as the ear heads turned to brownish color coupled with straw turned to yellowish color is more than 50 per cent plants. The ear heads and straw were harvested from the net plot of each treatment separately. After drying the ear heads were threshed and grain was separated by winnowing and then dried grain and straw weight were recorded separately.

3.7 Collection of Experimental Data

Randomly selected five plants from each plot and labeled them for recording biometric observations at 30 (30 days after sowing / 8 days after transplanting), 60 (60days after sowing / 38days after transplanting), 90 (90 days after sowing / 68 days after transplanting) and at harvest. The procedure followed for measuring various growth and yield parameters are given below.

3.7.1 Growth parameters

3.7.1.1 Sampling techniques

The randomly selected and tagged five plants were used for recording different parameters. For the observations like dry weight of the plants, leaf area etc., the plants from outside the net plot were uprooted and brought to laboratory for measurement.

Parameters	Procedure followed
Plant height (cm)	Plant height of finger millet was measured from ground level to the growing tip and then average of five plants was taken as plant height and expressed in centimeter.
Number of tillers Plant ⁻¹	Number of tillers from the main stem was counted and the mean was computed.
Number of leaves Plant ⁻¹	The number of fully grown green functional leaves was counted in each of the five plants and average was taken as number of leaves per plant at all stages of crop growth.

Leaf area (cm ² plant ⁻¹)	The leaf area (cm ²) was recorded using factor method by taking length and breadth of leaves of randomly selected five plants. Factor 0.70 used for estimation of leaf area.
Leaf area index (LAI)	Leaf area index is computed by using the following formula $LAI = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Spacing (cm}^2\text{)}} \text{ (Watson, 1952)}$
Leaf area duration (LAD) (in days)	Leaf area duration is computed by using the following formula $LAD = \frac{LAI_1 + LAI_2}{2} \times (t_2 - t_1) \text{ (Power et al., 1967)}$ Where, LAI=leaf area index t ₁ = LAI at time t ₁ ; t ₂ = LAI at time t ₂
Total dry matter accumulation (g plant ⁻¹)	The plant samples were dried separately at 65 ⁰ C±5 in hot air even till attainment of constant weight. Completely dried samples were weighed and the dry weight plant was expressed in gram per plant.

3.7.2 Yield and yield attributing parameters

3.7.2.1 Sampling techniques

The randomly selected and tagged five plants were used for recording different parameters.

Parameters	Procedure followed
Number of productive tillers hill ⁻¹	The numbers of productive tillers hill ⁻¹ were counted from the five tagged plants and their average was taken.
Number of ear head plant ⁻¹	Number of ear head plant ⁻¹ was recorded from the five randomly selected plants.
Number of fingers ear head ⁻¹	The number of fingers of individual ear head in a plant was counted and their average was taken.
Thousand grain weight(g)	Weight of thousand grains drawn at random from the seeds of five labeled plants was recorded and expressed in grams.
Grain yield(quintals ha ⁻¹)	From net plot area ear heads are harvested separately and sun dried for 4-5 days in the threshing yard. Threshing and winnowing was done, and then grain weight was recorded in kilograms and later converted into quintals ha ⁻¹ .

Straw yield(quintals ha ⁻¹)	From the net plot straw was cut at ground level for each treatment and sun dried for 8-10 days, weighted and converted to quintals ha ⁻¹ .
Harvest index	$HI = \frac{\text{Grain yield (quintals ha}^{-1}\text{)}}{\text{Biological yield (quintals ha}^{-1}\text{)}} \text{ (Donald, 1962)}$

3.8 Soil sampling and analysis

3.8.1 Soil sample collection and preparation

Representative soil samples from 0-15 cm depth was collected before land preparation in the selected site for analysis from experimental site before the commencement of the experiment and analyzed for different physico-chemical properties and available nutrients by following standard procedures.

Similarly, representative soil samples from 0-15 cm depth was collected at harvest of the crop and brought to the laboratory, dried in the shade and ground using wooden mortar and pestle, passed through 2 mm sieve and stored in an air tight container for further analysis.

3.8.2 Soil analysis

3.8.2.1 Soil pH

For determination of soil pH, the soil and water suspension of 1: 2.5 is used and determined by Potentiometry method as described by Piper (1966).

3.8.2.2 Electrical Conductivity

Electrical conductivity of soil was determined in 1: 2.5 ratio of soil and water extract using conductivity bridge method as described by Jackson (1973) and expressed as dS m⁻¹ at 25°C.

3.8.2.3 Organic Carbon

The organic carbon content of a finely ground soil sample was determined by Walkely and Black's wet oxidation method as described by Jackson (1967) and expressed in per cent.

3.8.2.4 Available Nitrogen

The alkaline potassium permanganate method of Subbaiah & Asija (1956) was adopted for the estimation of available N content in the soil.

3.8.2.5 Available Phosphorus

Available P content was extracted by using Bray's extraction (0.03 N NH₄F + 0.025 N HCl). The P content in the extract was determined by chloromolybdic blue

colour method using spectrophotometer. The intensity of blue color was determined at 660 nm. The available P content was computed and expressed in kg ha⁻¹ (Jackson 1973).

3.8.2.6 Available Potassium.

Available potassium in soil was extracted by using neutral normal ammonium acetate and the concentration of potassium in the extract was estimated by flame photometer. The available potassium was computed and expressed in kg K₂O ha⁻¹ (Jackson, 1973).

3.9 Plant Analysis

Ragi plant samples collected from each plot at the time of 30 (30 days after sowing/ 8 days after transplanting), 60 (60days after sowing / 38days after transplanting), 90 (90 days after sowing / 68 days after transplanting) and at harvest were dried and then grounded separately using mixer or grinder and pass through 40 mesh sieve. The grounded material was collected in butter paper bags and later used for chemical analysis.

3.9.1 Nitrogen

To determine the total N in grain and straw, the powdered sample was digested with concentrated H₂SO₄ and digestion mixture (K₂SO₄ + CuSO₄ 5H₂O + selenium powder at 100:20:1 ratio) after complete digestion, the content was transferred to distillation unit and the liberated ammonia was trapped in boric acid. It was titrated against standard acid (H₂SO₄) to estimate the N content (Jackson, 1973).

3.9.2 Digestion of the Plant Samples

For analysis of phosphorus and potassium, one gram of powdered plant samples were pre digested with 10 ml of tri-acid mixture (HNO₃: HClO₄: H₂SO₄ at 9:4:1), until colorless and clear residue was developed. After cooling the residue was dissolved in distilled water and then volume was made up to 50ml. Then the sample was used for P and K estimation.

3.9.2.1 Phosphorus

Phosphorus content in samples was determined by vanadomolybdo phosphoric yellow colour method by using spectrophotometer at 470 nm (Jackson, 1973) and expressed in per cent and converted into kg ha⁻¹ based on dry matter.

3.9.2.2 Potassium

Potassium content in plant sample was determined by flame photometric method (Jackson, 1973) and was expressed in percentage and converted into kg ha⁻¹ based on dry matter.

3.10 Nutrient Uptake

Nitrogen, phosphorus and potassium uptake was calculated for crop for each treatment separately using the formula and expressed in kg ha⁻¹.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrition concentration (\%)} \times \text{Yield of grain/straw (kg ha}^{-1}\text{)}}{100}$$

3.11 Economic Analysis

3.11.1 Cost of cultivation

In computing the economics, different variable cost items were considered. The cost includes expenditure on land preparation, seed, chemical fertilizers, plant protection chemicals and labour charges at prevailing market prices during 2016. The labor requirement was worked out on the basis of laborers engaged for different field operations.

3.11.2 Returns

The utility of adopting different practices was computed by using the following formulae.

Gross returns = market price X total yield (q ha⁻¹) (Grain yield + straw yield) (Rs.ha⁻¹)

Net returns (Rs.ha⁻¹) = gross returns – cost of cultivation

$$\text{B: C Ratio} = \frac{\text{Net returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

3.12 Statistical analysis

The experimental data collected on various growth and yield components of plant were subjected to fisher's method of analysis of variance (ANOVA) as outlined by Gomez and Gomez (1984). Whenever F –test was significant for comparison amongst the treatments means an appropriate value of critical differences (CD) was worked out. Otherwise against CD values abbreviation NS (Non –Significant) was indicated.

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

The results of the experiment entitled “Effect of different potassium levels and time of application on growth and yield of finger millet [*Eleusine coracana* (L.) Gaertn.] under drill sown and transplanted conditions” conducted during *Kharif* 2016 at AHRS, Bhavikere, UAHS, Shivamogga, are presented in this chapter.

4.1 Effect of methods of establishment, different potassium levels and time of application on growth parameters of finger millet

The data on growth components *viz.*, plant height, number of leaves, leaf area, leaf area index, leaf area duration, number of tillers and total dry matter accumulation as influenced by method of establishment, different potassium levels and time of application are presented in Table: 4.1 to 4.7.

4.1.1 Plant height

Plant height of finger millet recorded at different growth stages as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.1.

At 30 days, plant height influenced significantly due to methods of establishment. Drill sown method recorded significantly higher plant height (28.29 cm) compared to transplanting method (23.07 cm). Among the potassium levels, significantly higher plant height were recorded with application of 37.5 kg K₂O ha⁻¹ (28.63 cm) compared to 25 kg K₂O ha⁻¹ application (21.31 cm). However, it was on par with 50 kg K₂O ha⁻¹ (27.11cm). Time of application also influenced significantly on plant height. Basal application of potassium fertilizer recorded significantly higher plant height (26.26 cm) than application of 50 per cent as basal and as 50 per cent top dressing (25.09 cm). Among all the interaction effects method of establishment × potassium levels showed significant effect. Drill sown + application of 37.5 kg K₂O ha⁻¹ recorded significantly superior plant height (31.97) over all the treatments. Significantly lower interaction effect was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (22.05 cm). Remaining all interaction effects is found to be non - significant at 30 days.

At 60 days, 90 days and at harvest, plant height influenced significantly due to methods of establishment. Transplanting method recorded significantly higher plant height (68.72 cm, 86.37 cm and 105.87cm, respectively) compared to drill sowed (64.57 cm, 82.43cm and 100.65 cm, respectively). Among the potassium levels, significantly higher plant height was recorded with application of 37.5 kg K₂O ha⁻¹ (71.06 cm, 89.08 cm and 107.80 cm, respectively) compared to 25 kg K₂O ha⁻¹ (59.03 cm, 75.81 cm and 94.60 cm, respectively). However, it was on par with 50 kg K₂O ha⁻¹ (69.86 cm, 88.29 cm and 107.37 cm, respectively). Time of application also

Table 4.1: Plant height (cm) of finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	Plant height (cm) at 30 days	Plant height (cm) at 60 days	Plant height (cm) at 90 days	Plant height (cm) at harvest	Treatments	Plant height (cm) at 30 days	Plant height (cm) at 60 days	Plant height (cm) at 90 days	Plant height (cm) at harvest
M ₁	28.29	64.57	82.43	100.65	M ₂ T ₁	23.49	69.24	87.41	106.54
M ₂	23.07	68.72	86.37	105.87	M ₂ T ₂	22.64	68.20	85.32	105.21
SEM±	0.61	0.36	0.23	0.58	SEM±	0.87	0.51	0.32	0.83
CD at 5%	1.79	1.05	0.66	1.71	CD at 5%	NS	NS	NS	NS
Factor A (Method of establishment)					Factor B x Factor C				
Factor B (Potassium levels)									
K ₁	21.31	59.03	75.81	94.60	K ₁ T ₁	22.20	61.11	78.75	97.92
K ₂	28.63	71.06	89.08	107.80	K ₁ T ₂	20.42	56.95	72.88	91.29
K ₃	27.11	69.86	88.29	107.37	K ₂ T ₁	28.93	71.37	89.22	107.93
SEM±	0.75	0.44	0.28	0.71	K ₂ T ₂	28.33	70.75	88.95	107.67
CD at 5%	2.20	1.28	0.81	2.09	K ₃ T ₁	27.67	70.36	88.52	107.46
Factor C (Time of application)					K ₃ T ₂	26.54	69.37	88.06	107.29
T ₁	26.26	67.61	85.49	104.44	SEM±	1.06	0.62	0.39	1.01
T ₂	25.09	65.69	83.29	102.08	CD at 5%	NS	1.82	1.15	2.97
SEM±	0.61	0.36	0.23	0.58	Factor A x Factor B x Factor C				
CD at 5%	1.79	1.05	0.66	1.71	M ₁ K ₁ T ₁	23.57	58.15	74.44	94.32
Factor A x Factor B					M ₁ K ₁ T ₂	20.53	52.09	68.72	84.76
M ₁ K ₁	22.05	55.12	71.58	89.54	M ₁ K ₂ T ₁	32.25	70.89	88.62	106.63
M ₁ K ₂	31.97	70.32	88.38	106.08	M ₁ K ₂ T ₂	31.69	69.76	88.14	106.33
M ₁ K ₃	30.86	68.28	87.32	105.92	M ₁ K ₃ T ₁	31.30	68.91	87.69	106.05
M ₂ K ₁	20.56	62.94	80.05	99.67	M ₁ K ₃ T ₂	30.42	67.65	86.94	105.79
M ₂ K ₂	25.28	71.79	89.79	109.12	M ₂ K ₁ T ₁	20.83	64.07	83.07	101.52
M ₂ K ₃	23.35	71.44	89.26	108.83	M ₂ K ₁ T ₂	20.30	61.81	77.03	97.82
SEM±	1.06	0.62	0.39	1.01	M ₂ K ₂ T ₁	25.60	71.85	89.82	109.23
CD at 5%	3.12	1.82	1.15	2.97	M ₂ K ₂ T ₂	24.97	71.73	89.76	109.01
Factor A x Factor C					M ₂ K ₃ T ₁	24.03	71.81	89.35	108.87
M ₁ T ₁	29.04	65.98	83.58	102.33	M ₂ K ₃ T ₂	22.67	71.08	89.17	108.79
M ₁ T ₂	27.55	63.17	81.27	98.96	SEM±	1.502	0.88	0.55	1.43
					CD at 5%	NS	NS	NS	NS

30 days (30 DAS and 8 DAT), 60 days (60 DAS and 38 DAT), 90 days (90 DAS and 68 DAT)

DAS: days after sowing, DAT: days after transplanting, NS: Non-significant

NS: Non-significant

influenced the plant height, basal application of potassium fertilizer recorded significantly higher plant height (67.61 cm, 85.49 cm and 104.44 cm, respectively) compared to split application (65.69 cm, 83.29 cm and 102.08 cm, respectively).

Among all the interaction effects, method of establishment \times potassium levels and potassium levels \times time of application showed significant effect. Transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly superior plant height (71.79 cm, 89.79 cm and 109.12 cm, respectively) and it was on par with the transplanting + application of 50 kg K₂O ha⁻¹ (71.44 cm, 89.26 cm and 108.83 cm, respectively). Significantly the lowest plant height was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (55.12 cm, 71.58 cm and 89.54 cm, respectively).

Among the potassium levels \times time of application, basal application of 37.5 kg K₂O ha⁻¹ fertilizer recorded significantly superior plant height (71.37 cm, 89.22 cm and 107.93 cm, respectively) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (70.75 cm, 88.95 cm and 107.67 cm, respectively) followed by basal / split application of 50 kg K₂O ha⁻¹. Remaining all interaction effects is found to be non – significant. Interaction effect of method of establishment \times potassium levels \times time of application has no significant effect on plant height. However, the treatment combination having basal application of 37.5 kg ha⁻¹ of potassium under transplanted condition recorded higher plant height (71.85 cm, 89.82 cm and 109.23 cm, respectively).

4.1.2 Number of leaves plant⁻¹

The data on number of leaves plant⁻¹ as influenced by method of establishment, different potassium levels and time of application at various growth stages are presented in Table 4.2.

At 30 days, significant variation was not observed in the number of leaves plant⁻¹ between methods of establishment. However, the highest number of leaves plant⁻¹ (13.60) was recorded in drill sown condition compared to transplanted condition (11.77). Among the potassium levels, significantly higher number of leaves was recorded with application of 37.5 kg K₂O ha⁻¹ (14.85) compared to 25 kg K₂O ha⁻¹ (11.76). However, it was on par with 50 kg K₂O ha⁻¹ (14.45). Time of application also influenced the number of leaves, significant variation was not observed in the number of leaves plant⁻¹ between times of application. However, the highest number of leaves plant⁻¹ (13.92) was recorded in basal application compared to 50 per cent as basal and 50 per cent as topdressing (12.45). Among all the interaction effects, method of establishment \times potassium levels showed significant effect. Drill sowed + application of 37.5 kg K₂O ha⁻¹ showed significantly superior number of leaves plant⁻¹ (15.11) over all the treatments. Remaining all interaction effects is found to be non -significant at 30 days.

Table 4.2: Number of leaves of finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	Number of leaves at 30 days	Number of leaves at 60 days	Number of leaves at 90 days	Number of leaves at harvest	Treatments	Number of leaves at 30 days	Number of leaves at 60 days	Number of leaves at 90 days	Number of leaves at harvest
	Factor A (Method of establishment)								
M ₁	13.60	24.65	32.07	18.81	M ₂ T ₁	13.90	28.39	35.35	22.47
M ₂	11.77	27.85	35.03	21.93	M ₂ T ₂	13.64	27.30	34.72	21.39
SEm±	0.24	0.18	0.14	0.18	SEM±	0.35	0.25	0.19	0.26
CD at 5%	NS	0.52	0.40	0.54	CD at 5%	NS	NS	NS	NS
	Factor B (Potassium levels)					Factor B x Factor C			
K ₁	11.76	21.17	29.05	16.09	K ₁ T ₁	12.16	22.57	30.09	17.77
K ₂	14.85	29.07	36.03	22.73	K ₁ T ₂	11.37	19.76	28.01	18.55
K ₃	14.45	28.51	35.58	22.29	K ₂ T ₁	15.03	29.15	36.13	26.13
SEm±	0.30	0.22	0.17	0.22	K ₂ T ₂	14.66	28.99	35.93	25.91
CD at 5%	0.88	0.63	0.49	0.66	K ₃ T ₁	14.58	28.62	35.70	25.71
	Factor C (Time of application)					14.32	28.39	35.45	25.54
T ₁	13.92	26.78	33.97	21.01	SEM±	0.43	0.31	0.23	0.32
T ₂	12.45	25.71	33.13	19.73	CD at 5%	NS	0.90	0.69	0.934
SEm±	0.24	0.18	0.14	0.18		Factor A x Factor B x Factor C			
CD at 5%	NS	0.52	0.40	0.54	M ₁ K ₁ T ₁	11.71	20.49	29.03	16.31
	Factor A x Factor B				M ₁ K ₁ T ₂	10.10	17.78	26.33	12.14
M ₁ K ₁	10.86	19.14	27.68	14.22	M ₁ K ₂ T ₁	15.20	27.83	34.60	21.30
M ₁ K ₂	15.11	27.76	34.50	21.22	M ₁ K ₂ T ₂	14.98	27.68	34.4	21.17
M ₁ K ₃	14.84	27.04	34.03	20.98	M ₁ K ₃ T ₁	14.89	27.18	34.17	21.05
M ₂ K ₁	10.86	23.19	30.41	17.97	M ₁ K ₃ T ₂	14.78	26.91	33.90	20.90
M ₂ K ₂	15.11	30.38	37.57	24.22	M ₂ K ₁ T ₁	12.60	24.66	31.14	19.24
M ₂ K ₃	14.84	29.96	37.12	23.61	M ₂ K ₁ T ₂	12.73	21.73	29.68	16.70
SEm±	0.42	0.30	0.23	0.32	M ₂ K ₂ T ₁	14.83	30.47	37.67	24.47
CD at 5%	1.23	NS	NS	NS	M ₂ K ₂ T ₂	14.33	30.30	37.47	23.98
	Factor A x Factor C				M ₂ K ₃ T ₁	14.27	30.05	37.23	23.70
M ₁ T ₁	13.95	25.17	32.60	19.55	M ₂ K ₃ T ₂	13.86	29.88	37	26.85
M ₁ T ₂	13.25	24.13	31.54	18.07	SEM±	0.60	0.43	0.33	0.45
					CD at 5%	NS	NS	NS	NS

30 days (30 DAS and 8 DAT), 60 days (60 DAS and 38 DAT), 90 days (90 DAS and 68 DAT)

DAS: days after sowing, DAT: days after transplanting,

NS: Non-significant

At 60 days, 90 days and at harvest, transplanting method recorded significantly higher number of leaves plant⁻¹ (27.85, 35.03 and 21.93, respectively) compared to drill sowed (24.65, 32.07 and 18.81, respectively). Among the potassium levels, significantly higher number of leaves plant⁻¹ was recorded with application of 37.5 kg K₂O ha⁻¹ (29.07, 36.03 and 22.73, respectively) compared to 25 kg K₂O ha⁻¹ (21.17, 29.05 and 16.09, respectively). However, it was on par with 50 kg K₂O ha⁻¹ (28.51, 35.58 and 22.29, respectively). Time of application also influenced the number of leaves, basal application of potassium fertilizer recorded significantly higher number of leaves plant⁻¹ (26.78, 33.97 and 21.01, respectively) compared to split application (25.71, 33.13 and 19.73, respectively).

Among all the interaction effects, potassium levels × time of application showed significant effect. Basal application of 37.5 kg K₂O ha⁻¹ recorded significantly superior number of leaves plant⁻¹ (29.15, 36.13 and 26.13, respectively) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (28.99, 35.93 and 25.91, respectively) followed by basal or split application of 50 kg K₂O ha⁻¹. Remaining all interaction effects is found to be non – significant. Interaction effect of method of establishment × potassium levels × time of application has no significant effect on number of leaves per plant. However, the treatment combination having basal application of 37.5 kg ha⁻¹ of potassium under transplanted condition recorded higher number of leaves plant⁻¹ (30.47, 37.67 and 24.47, respectively).

4.1.3 Leaf area (cm² plant⁻¹)

The data on leaf area plant⁻¹ recorded at different growth stages as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.3.

At 30 days, significant variation was not observed in the leaf area between methods of establishment. However, the higher leaf area (138.75 cm² plant⁻¹) was recorded in transplanting compared to drill sown crop (136.90 cm² plant⁻¹). Significantly higher leaf area was recorded with application of 37.5 kg K₂O ha⁻¹ (148.62 cm² plant⁻¹) compared to 25 kg K₂O ha⁻¹ (121.49 cm² plant⁻¹). However, it was on par with 50 kg K₂O ha⁻¹ (143.38 cm² plant⁻¹). Significant variation was not observed in the leaf area between times of application. However, higher leaf area (139.58 cm² plant⁻¹) was recorded in basal application compared to split application (139.58 cm² plant⁻¹). Among all the interaction effects, method of establishment × potassium levels showed significant effect. Drill sowed + application of 37.5 kg K₂O ha⁻¹ showed significantly superior leaf area (152.49 cm² plant⁻¹) over all the treatment combinations. Remaining all interaction effects is found to be non - significant at 30 days.

Table 4.3: Leaf area (cm² plant⁻¹) of finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	Leaf area at 30 days	Leaf area at 60 days	Leaf area at 90 days	Leaf area at harvest	Treatments	Leaf area at 30 days	Leaf area at 60 days	Leaf area at 90 days	Leaf area at harvest
M ₁	136.90	560.94	852.68	526.76	M ₂ T ₁	139.15	585.75	894.34	593.28
M ₂	138.75	581.46	885.59	582.10	M ₂ T ₂	138.36	577.16	876.84	570.91
SEm±	1.21	2.40	3.56	4.18	SEm±	1.71	3.39	5.04	5.91
CD at 5%	NS	7.04	10.46	12.25	CD at 5%	NS	NS	NS	NS
Factor B (Potassium levels)					Factor B x Factor C				
K ₁	121.49	522.36	778.66	465.82	K ₁ T ₁	125.66	535.87	798.57	487.57
K ₂	148.62	597.86	920.66	606.19	K ₁ T ₂	117.32	508.86	758.74	444.07
K ₃	143.38	593.36	908.08	591.28	K ₂ T ₁	149.09	599.10	926.01	608.85
SEm±	1.48	2.94	4.37	5.12	K ₂ T ₂	148.15	596.62	915.31	603.53
CD at 5%	4.35	8.63	12.81	15.01	K ₃ T ₁	143.99	594.96	912.13	598.54
Factor C (Time of application)					Factor A x Factor B x Factor C				
T ₁	139.58	576.65	878.91	564.99	SEm±	2.1	4.16	6.17	7.24
T ₂	136.08	565.75	859.36	543.87	CD at 5%	NS	12.20	18.12	21.23
SEm±	1.21	2.40	3.56	4.18					
CD at 5%	NS	7.04	10.46	12.25	M ₁ K ₁ T ₁	116.59	518.59	772.41	454.11
Factor A x Factor B					M ₁ K ₁ T ₂	101.82	485.15	734.75	411.26
M ₁ K ₁	109.21	501.87	753.58	432.68	M ₁ K ₂ T ₁	153.19	594.01	915.78	584.16
M ₁ K ₂	152.49	592.47	911.18	581.37	M ₁ K ₂ T ₂	151.79	590.92	901.58	578.57
M ₁ K ₃	149.01	588.47	893.27	566.23	M ₁ K ₃ T ₁	150.23	590.02	897.23	571.79
M ₂ K ₁	133.77	542.86	803.74	498.96	M ₁ K ₃ T ₂	147.78	586.91	889.31	560.66
M ₂ K ₂	144.73	603.25	930.15	631.01	M ₂ K ₁ T ₁	134.72	553.16	824.74	521.04
M ₂ K ₃	137.75	598.26	922.88	616.32	M ₂ K ₁ T ₂	132.82	532.56	782.73	476.88
SEm±	2.1	4.16	6.17	7.24	M ₂ K ₂ T ₁	144.97	604.19	931.24	633.54
CD at 5%	6.16	12.20	NS	NS	M ₂ K ₂ T ₂	144.49	602.32	929.05	628.49
Factor A x Factor C					M ₂ K ₃ T ₁	137.74	599.91	927.04	625.28
M ₁ T ₁	140.01	567.54	863.47	536.69	M ₂ K ₃ T ₂	137.77	596.61	918.72	607.37
M ₁ T ₂	133.80	554.33	841.88	516.83	SEm±	2.97	5.88	8.73	10.23
					CD at 5%	NS	NS	NS	NS

30 days (30 DAS and 8 DAT), 60 days (60 DAS and 38 DAT), 90 days (90 DAS and 68 DAT)

DAS: days after sowing, DAT: days after transplanting,

NS: Non-significant

At 60 days, 90 days and at harvest, leaf area influenced due to method of establishment. Transplanting method recorded significantly leaf area ($581.46 \text{ cm}^2 \text{ plant}^{-1}$, $885.59 \text{ cm}^2 \text{ plant}^{-1}$ and $582.1 \text{ cm}^2 \text{ plant}^{-1}$, respectively) compared to drill sowed ($560.94 \text{ cm}^2 \text{ plant}^{-1}$, $852.68 \text{ cm}^2 \text{ plant}^{-1}$ and $526.76 \text{ cm}^2 \text{ plant}^{-1}$, respectively). Among the potassium levels, significantly higher leaf area was recorded with application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ ($597.86 \text{ cm}^2 \text{ plant}^{-1}$, $920.66 \text{ cm}^2 \text{ plant}^{-1}$ and $606.19 \text{ cm}^2 \text{ plant}^{-1}$, respectively) compared to $25 \text{ kg K}_2\text{O ha}^{-1}$ ($522.36 \text{ cm}^2 \text{ plant}^{-1}$, $778.66 \text{ cm}^2 \text{ plant}^{-1}$ and $465.82 \text{ cm}^2 \text{ plant}^{-1}$, respectively). However, it was on par with $50 \text{ kg K}_2\text{O ha}^{-1}$ ($593.36 \text{ cm}^2 \text{ plant}^{-1}$, $908.08 \text{ cm}^2 \text{ plant}^{-1}$ and $591.28 \text{ cm}^2 \text{ plant}^{-1}$, respectively). Basal application of potassium fertilizer recorded significantly higher leaf area ($576.65 \text{ cm}^2 \text{ plant}^{-1}$, $878.91 \text{ cm}^2 \text{ plant}^{-1}$ and $564.99 \text{ cm}^2 \text{ plant}^{-1}$, respectively) compared to application of 50 per cent as basal and 50 per cent as top dressing ($565.75 \text{ cm}^2 \text{ plant}^{-1}$, $859.36 \text{ cm}^2 \text{ plant}^{-1}$ and $543.87 \text{ cm}^2 \text{ plant}^{-1}$, respectively).

Among all the interaction effects, potassium levels \times time of application showed significant effect. Basal application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ recorded significantly superior leaf area ($599.10 \text{ cm}^2 \text{ plant}^{-1}$, $926.01 \text{ cm}^2 \text{ plant}^{-1}$ and $608.85 \text{ cm}^2 \text{ plant}^{-1}$, respectively) and it was on par with the split application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ ($596.62 \text{ cm}^2 \text{ plant}^{-1}$, $915.31 \text{ cm}^2 \text{ plant}^{-1}$ and $603.53 \text{ cm}^2 \text{ plant}^{-1}$, respectively) followed by basal / split application of $50 \text{ kg K}_2\text{O ha}^{-1}$. Remaining all interaction effects is found to be non – significant. Interaction effect of method of establishment \times potassium levels \times time of application has no significant effect on leaf area per plant. However, the treatment combination having basal application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ under transplanted condition noted higher leaf area ($604.19 \text{ cm}^2 \text{ plant}^{-1}$, $931.24 \text{ cm}^2 \text{ plant}^{-1}$ and $633.54 \text{ cm}^2 \text{ plant}^{-1}$, respectively).

4.1.4 Leaf area index

The data on leaf area index as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.4.

At 30 days, significant variation was not observed in the leaf area index between methods of establishment. Significantly higher leaf area index was recorded with application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ (0.49) compared to $25 \text{ kg K}_2\text{O ha}^{-1}$ (0.40). However, it was on par with the application of $50 \text{ kg K}_2\text{O ha}^{-1}$ (0.48). Significant variation was observed in the leaf area index between times of application. Basal application of potassium fertilizer recorded significantly higher leaf area index (0.46) compared to split application (0.45). Among all the interaction effects method of establishment \times potassium levels showed significant effect. Drill sowed + application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ showed significantly more leaf area index (0.51) over all the treatment combinations. Remaining all interaction effects is found to be non - significant at 30 days.

Table 4.4: Leaf area index (LAI) of finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	LAI at 30 days	LAI at 60 days	LAI at 90 days	LAI at harvest	Treatments	LAI at 30 days	LAI at 60 days	LAI at 90 days	LAI at harvest
M ₁	0.46	1.87	2.84	1.75	M ₂ T ₁	0.46	1.95	2.98	1.97
M ₂	0.46	1.94	2.95	1.94	M ₂ T ₂	0.46	1.92	2.93	1.90
SEM±	0.004	0.008	0.012	0.014	SEM±	0.006	0.011	0.017	0.02
CD at 5%	NS	0.024	0.035	0.041	CD at 5%	NS	NS	NS	NS
Factor B (Potassium levels)									
K ₁	0.40	1.74	2.59	1.55	K ₁ T ₁	0.42	1.79	2.66	1.62
K ₂	0.49	1.99	3.07	2.02	K ₁ T ₂	0.39	1.69	2.53	1.48
K ₃	0.48	1.98	3.03	1.97	K ₂ T ₁	0.49	1.99	3.09	2.03
SEM±	0.005	0.01	0.016	0.017	K ₂ T ₂	0.49	1.99	3.05	2.01
CD at 5%	0.015	0.029	0.043	0.05	K ₃ T ₁	0.48	1.98	3.04	1.99
Factor C (Time of application)									
T ₁	0.47	1.92	2.93	1.88	K ₃ T ₂	0.48	1.97	3.01	1.95
T ₂	0.45	1.89	2.86	1.81	SEM±	0.007	0.014	0.021	0.024
SEM±	0.004	0.008	0.012	0.014	CD at 5%	NS	NS	NS	0.071
CD at 5%	0.012	0.024	0.035	0.041	Factor A x Factor B x Factor C				
Factor A x Factor B									
M ₁ K ₁	0.36	1.67	2.51	1.44	M ₁ K ₁ T ₁	0.39	1.73	2.57	1.51
M ₁ K ₂	0.51	1.97	3.04	1.93	M ₁ K ₁ T ₂	0.34	1.62	2.45	1.37
M ₁ K ₃	0.49	1.96	2.98	1.89	M ₁ K ₂ T ₁	0.51	1.98	3.06	1.94
M ₂ K ₁	0.45	1.81	2.68	1.66	M ₁ K ₂ T ₂	0.51	1.97	3.00	1.93
M ₂ K ₂	0.48	2.01	3.10	2.10	M ₁ K ₃ T ₁	0.50	1.97	2.99	1.91
M ₂ K ₃	0.46	1.99	3.08	2.05	M ₁ K ₃ T ₂	0.49	1.96	2.96	1.87
SEM±	0.007	0.014	0.021	0.024	M ₂ K ₁ T ₁	0.45	1.84	2.75	1.74
CD at 5%	0.021	0.041	NS	NS	M ₂ K ₁ T ₂	0.44	1.77	2.61	1.59
Factor A x Factor C									
M ₁ T ₁	0.47	1.89	2.88	1.79	M ₂ K ₂ T ₁	0.48	2.01	3.11	2.11
M ₁ T ₂	0.45	1.85	2.81	1.72	M ₂ K ₂ T ₂	0.48	2.01	3.10	2.09
30 days (30 DAS and 8 DAT), 60 days (60 DAS and 38 DAT), 90 days (90 DAS and 68 DAT)									
DAS: days after sowing, DAT: days after transplanting, NS: Non-significant									
SEM±									
CD at 5%									
NS									

At 60 days, methods of establishment had significant effect on leaf area index. The highest leaf area index was found in transplanting (1.94) compared to drill sown condition (1.87). Among the potassium levels, significantly higher leaf area index were recorded with application of 37.5 kg K₂O ha⁻¹ (1.99) compared to 25 kg K₂O ha⁻¹ (1.74). However, it was on par with the application of 50 kg K₂O ha⁻¹ (1.98). Significant variation was observed in the leaf area index between times of application. Time of application also influenced the leaf area index, basal application of potassium fertilizer significantly recorded higher leaf area index (1.92) compared to split application (1.89). Among the interactions, method of establishment × potassium levels showed significant effect. Transplanting + application of 37.5 kg K₂O ha⁻¹ significantly recorded higher leaf area index (2.01) over all the treatment combinations. Remaining all interaction effects is found to be non-significant at 60 days.

At 90 days, significantly higher leaf area index was found in transplanted condition (2.95) than in drill sown condition (2.84). Among the potassium levels, significantly higher leaf area index was recorded with application of 37.5 kg K₂O ha⁻¹ (3.07) compared to 25 kg K₂O ha⁻¹ (2.59). However, it was on par with the application of 50 kg K₂O ha⁻¹ (3.03). Significant variation was observed in the Leaf area index between times of application. Time of application also influenced the leaf area index, basal application of potassium fertilizer recorded significantly higher leaf area index (2.93) compared to split application (2.86). The Leaf area index did not differ significantly due to interaction effects between method of establishment, different potassium levels and time of application.

At harvest, methods of establishment had significant effect on leaf area index. Significantly higher leaf area index was found in transplanted condition (2.02) compared to drill sown condition (1.75). Among the potassium level, significantly higher leaf area index was recorded with application of 37.5 kg K₂O ha⁻¹ (3.07) compared to 25 kg K₂O ha⁻¹ (1.55). However, it was on par with the application of 50 kg K₂O ha⁻¹ (1.97). Time of application also influenced the leaf area index, basal application of potassium fertilizer recorded significantly higher leaf area index (1.88) compared to split application (1.81). Among all the interaction effects, potassium levels × time of application showed significant effect. Basal application 37.5 kg K₂O ha⁻¹ recorded significantly superior leaf area index (2.03) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (1.99) followed by Basal/split application of 50 kg K₂O ha⁻¹. Remaining all interaction effects is found to be non-significant at harvest days.

4.1.5 Leaf area duration (days)

The data on leaf area duration of finger millet as influenced by method of establishment, different potassium levels and time of application at various growth stages are presented in Table 4.5.

At 30-60 days, significant variation was observed in leaf area duration between methods of establishment. Transplanting method recorded significantly higher leaf area duration (29.53) compared to drill sown method (28.50). Among the different potassium levels, significantly higher leaf area duration were recorded with application of 37.5 kg K₂O ha⁻¹ (30.39) compared to application of 25 kg K₂O ha⁻¹. However, it was on par with the application of 50 kg K₂O ha⁻¹ (30.15). Leaf area duration influenced by time of application, basal application of potassium fertilizer recorded significantly higher leaf area duration (29.29) compared to split application (28.74).

All the interaction effects showed significant effect except interaction of all three factors. Among the interactions of methods of establishment × potassium levels, transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly superior leaf area duration (30.64) and it was on par with transplanting + application of 50 kg K₂O ha⁻¹. Significantly lower leaf area index was recorded with drill sown crop + application of 25 kg K₂O ha⁻¹ (25.46). Among the interactions of methods of establishment × time of application, transplanting + basal application of potassium fertilizer showed higher leaf area duration (29.75) over other treatments and significantly lower leaf area index was recorded with drill sown crop + split application of potassium (28.16). In the interaction effects of potassium levels × time of application, 37.5 kg K₂O ha⁻¹ + basal applications recorded significantly superior leaf area duration (30.45) and it was on par with the 37.5 kg K₂O ha⁻¹ + split applications (30.32). Significantly lower leaf area duration was recorded with 25 kg K₂O ha⁻¹ + split application (25.83).

At 60-90 days, transplanting method recorded significantly higher leaf area duration (29.53) compared to drill sown method (28.50). Among the potassium levels, significantly higher leaf area duration were recorded with application of 37.5 kg K₂O ha⁻¹ (48.03) compared to application of 25 kg K₂O ha⁻¹ (40.67). However, it was on par with 50 kg K₂O ha⁻¹ (47.38). Leaf area duration influenced by time of application, basal application of fertilizer observed significantly higher leaf area duration (45.87) than split application (44.85). Among the interaction effects, method of establishment × potassium levels and potassium levels × time of application recorded significant variation. Transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly superior leaf area duration (48.52) and it was on par with the transplanting + application of 50 kg K₂O ha⁻¹ (48.14). Significantly lower leaf area duration was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (39.35). Among the

Table 4.5: Leaf area duration of finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	LAD at 30-60 days	LAD at 60-90 days	LAD at 90 - harvest	Treatments	LAD at 30-60 days	LAD at 60-90 days	LAD at 90 - harvest
	Factor A (Method of establishment)						
M ₁	28.50	44.50	20.39	M ₂ T ₁	29.75	46.67	22.76
M ₂	29.53	46.23	22.35	M ₂ T ₂	29.32	45.77	21.95
SEm±	0.12	0.17	0.14	SEm±	0.17	0.24	0.20
CD at 5%	0.36	0.51	0.42	CD at 5%	0.49	NS	NS
	Factor B (Potassium levels)			Factor B x Factor C			
K ₁	26.52	40.67	18.12	K ₁ T ₁	27.21	41.71	18.91
K ₂	30.39	48.03	23.26	K ₁ T ₂	25.83	39.63	17.33
K ₃	30.15	47.38	22.74	K ₂ T ₁	30.45	48.29	23.35
SEm±	0.15	0.21	0.18	K ₂ T ₂	30.32	47.75	23.17
CD at 5%	0.43	0.62	0.52	K ₃ T ₁	30.23	47.59	22.99
	Factor C (Time of application)			K ₃ T ₂	30.06	47.17	22.48
T ₁	29.29	45.87	21.75	SEm±	0.21	0.30	0.25
T ₂	28.74	44.85	20.99	CD at 5%	0.61	0.88	0.73
SEm±	0.12	0.17	0.14	Factor A x Factor B x Factor C			
CD at 5%	0.36	0.51	0.42	M ₁ K ₁ T ₁	26.32	40.35	17.71
	Factor A x Factor B			M ₁ K ₁ T ₂	24.59	38.36	16.16
M ₁ K ₁	25.46	39.35	16.93	M ₁ K ₂ T ₁	30.21	48.02	22.47
M ₁ K ₂	30.13	47.53	22.38	M ₁ K ₂ T ₂	30.05	47.05	22.29
M ₁ K ₃	29.92	46.62	21.85	M ₁ K ₃ T ₁	30.00	46.83	22.05
M ₂ K ₁	27.59	41.99	19.31	M ₁ K ₃ T ₂	29.84	46.42	21.65
M ₂ K ₂	30.64	48.52	24.13	M ₂ K ₁ T ₁	30.00	43.08	20.12
M ₂ K ₃	30.37	48.14	23.62	M ₂ K ₁ T ₂	29.84	40.91	18.50
SEm±	0.21	0.30	0.25	M ₂ K ₂ T ₁	28.11	48.57	24.22
CD at 5%	0.61	0.88	NS	M ₂ K ₂ T ₂	27.07	48.46	24.05
	Factor A x Factor C			M ₂ K ₃ T ₁	30.45	48.35	23.93
M ₁ T ₁	28.84	45.06	20.75	M ₂ K ₃ T ₂	30.29	47.82	23.30
M ₁ T ₂	28.16	43.94	20.03	SEm±	0.30	0.42	0.35
				CD at 5%	NS	NS	NS

NS: Non-significant

potassium levels \times time of application, potassium level of 37.5 kg ha⁻¹ + basal application recorded significantly superior leaf area duration (48.29) and it was on par with the split application of 37.5 kg ha⁻¹ of potassium (47.75) followed by basal / split application of 50 kg ha⁻¹ of potassium fertilizer. Remaining all interaction effects is found to be non - significant at 60-90 days. However, numerically the treatment combination with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition recorded higher leaf area duration (48.57) and lower leaf area duration was recorded with drill sown condition with split application of 25 kg K₂O ha⁻¹ (38.36) in the interaction of all the three factors.

Leaf area duration at 90-110 days, transplanting method recorded significantly higher leaf area duration (22.35) compared to drill sowed (20.39). Significantly higher leaf area duration was recorded with application of 37.5 kg K₂O ha⁻¹ (23.26) compared to application of 25 kg K₂O ha⁻¹ (18.12). However, it was on par with application of 50 kg K₂O ha⁻¹ (22.74). Time of application also influenced the leaf area duration, basal application of fertilizer significantly observed higher leaf area duration (21.75) compared to split application (20.99). Among the interaction effects, potassium levels \times time of application showed significant variation. Potassium level of 37.5 kg ha⁻¹ + basal application recorded significantly superior leaf area duration (24.22) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (23.17) followed by basal / split application of 50 kg K₂O ha⁻¹. Remaining all interaction effects is found to be non - significant at 90-110 days. However, numerically higher leaf area duration (24.22) was recorded with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition and lower leaf area duration was recorded with drill sown condition with split application of 25 kg K₂O ha⁻¹ (16.16) in the interaction of all the three factors.

4.1.6 Number of tillers hill⁻¹

The data on number of tillers hill⁻¹ as influenced by method of establishment, different potassium levels and time of application at various growth stages are presented in Table 4.6.

At 30 days, number of tillers influenced due to methods of establishment, drill sown condition recorded significantly higher number of tillers (2.04) compare to transplanting (1.09). Significantly higher number of tillers was recorded with application of 37.5 kg K₂O ha⁻¹ (1.71) compared to 25 kg K₂O ha⁻¹ (1.34). However, it was on par with the application of 50 kg K₂O ha⁻¹ (1.64). Basal application of potassium fertilizer recorded significantly higher number of tillers (1.59) compared to application of potassium as 50 per cent as basal and 50 per cent as top dressing (1.53). Among all the interactions, method of establishment \times potassium levels showed significant effect. Drill sowed + application of 37.5 kg K₂O ha⁻¹ recorded significantly superior number of tillers (2.24) over all the treatments. Significantly lower number of

Table 4.6: Number of tillers in finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	Number of tillers hill ⁻¹ at 30 days	Number of tillers hill ⁻¹ at 60 days	Number of tillers hill ⁻¹ at 90 days	Number of tillers hill ⁻¹ at harvest	Treatments	Number of tillers hill ⁻¹ at 30 days	Number of tillers hill ⁻¹ at 60 days	Number of tillers hill ⁻¹ at 90 days	Number of tillers hill ⁻¹ at harvest
	Factor A (Method of establishment)								
M ₁	2.04	3.39	4.41	4.56	M ₂ T ₁	1.11	3.75	4.65	4.83
M ₂	1.09	3.69	4.66	4.77	M ₂ T ₂	1.08	3.65	4.59	4.78
SEm±	0.02	0.025	0.013	0.018	SEm±	0.03	0.025	0.019	0.03
CD at 5%	0.06	0.074	0.04	0.054	CD at 5%	NS	NS	NS	NS
	Factor B (Potassium levels)					Factor B x Factor C			
K ₁	1.34	3.00	4.07	4.12	K ₁ T ₁	1.41	3.22	4.23	4.32
K ₂	1.71	3.84	4.79	4.98	K ₁ T ₂	1.27	2.78	3.91	3.93
K ₃	1.64	3.78	4.75	4.89	K ₂ T ₁	1.73	3.85	4.79	4.99
SEm±	0.02	0.031	0.017	0.023	K ₂ T ₂	1.70	3.83	4.78	4.96
CD at 5%	0.07	0.091	0.04	0.066	K ₃ T ₁	1.66	3.79	4.76	4.90
	Factor C (Time of application)								
T ₁	1.59	3.62	4.59	4.74	SEm±	0.04	0.044	0.023	0.023
T ₂	1.53	3.46	4.48	4.59	CD at 5%	NS	0.129	0.069	0.09
SEm±	0.02	0.025	0.013	0.018		Factor A x Factor B x Factor C			
CD at 5%	0.06	0.074	0.04	0.054	M ₁ K ₁ T ₁	1.80	3.03	4.07	4.20
	Factor A x Factor B					M ₁ K ₁ T ₂	1.56	2.43	3.66
M ₁ K ₁	1.68	2.73	3.86	3.95	M ₁ K ₂ T ₁	2.25	3.77	4.92	4.92
M ₁ K ₂	2.24	3.76	4.70	4.92	M ₁ K ₂ T ₂	2.23	3.75	4.69	4.91
M ₁ K ₃	2.19	3.67	4.66	4.80	M ₁ K ₃ T ₁	2.20	3.68	4.67	4.81
M ₂ K ₁	0.99	3.27	4.27	4.30	M ₁ K ₃ T ₂	2.19	3.66	4.66	4.79
M ₂ K ₂	1.19	3.93	4.87	5.04	M ₂ K ₁ T ₁	1.02	3.40	4.37	4.43
M ₂ K ₃	1.09	3.89	4.84	4.99	M ₂ K ₁ T ₂	0.97	3.13	4.17	4.17
SEm±	0.04	0.044	0.023	0.03	M ₂ K ₂ T ₁	1.21	3.94	4.88	5.06
CD at 5%	0.11	0.129	0.069	0.09	M ₂ K ₂ T ₂	1.17	3.92	4.86	5.01
	Factor A x Factor C					M ₂ K ₃ T ₁	1.11	3.90	4.85
M ₁ T ₁	2.08	3.49	4.48	4.65	M ₂ K ₃ T ₂	1.09	3.88	4.83	4.97
M ₁ T ₂	1.99	3.28	4.34	4.47	SEm±	0.051	0.062	0.033	0.045
					CD at 5%	NS	NS	NS	NS

30 days (30 DAS and 8 DAT), 60 days (60 DAS and 38 DAT), 90 days (90 DAS and 68 DAT)

DAS: days after sowing, DAT: days after transplanting,

NS: Non-significant

tillers was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (1.68). Remaining all interaction effects is found to be non - significant at 30 days.

At 60 days, 90 days and at harvest, transplanting method recorded significantly higher number of tillers (3.69, 4.66 and 4.77, respectively) compared to drill sowed (3.39, 4.41 and 4.56, respectively). Among the potassium levels, significantly higher number of tillers was recorded with application of 37.5 kg K₂O ha⁻¹ (3.84, 4.79 and 4.98, respectively) compared to 25 kg K₂O ha⁻¹ (3.00, 4.07 and 4.12, respectively). However, it was on par with 50 kg ha⁻¹ of potassium (3.78, 4.75 and 4.89, respectively). Time of application also influenced the number of tillers, basal application of potassium fertilizer recorded significantly higher number of tillers (3.62, 4.59 and 4.74, respectively) compared to application of potassium as 50 per cent as basal and 50 per cent as top dressing (3.46, 4.48 and 4.59, respectively).

Among all the interaction effects, method of establishment × potassium levels and potassium levels × time of application showed significant effect. Transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly superior number of tillers (3.93, 4.87 and 5.04, respectively) and it was on par with the transplanting + application of 50 kg K₂O ha⁻¹ (3.89, 4.84 and 4.99, respectively). Significantly lower number of tillers was recorded with drill sown condition + application of 25 kg K₂O ha⁻¹ (2.73, 3.86 and 3.95, respectively).

Among the potassium levels × time of application, basal application of 37.5 kg K₂O ha⁻¹ recorded significantly superior number of tillers (3.85, 4.79 and 4.99, respectively) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (3.83, 4.78 and 4.96, respectively) followed by basal / split application of 50 kg K₂O ha⁻¹. Remaining all interaction effects is found to be non – significant. Interaction effect of method of establishment × potassium levels × time of application has no significant effect on number of tillers. However, numerically higher number of tillers (3.94, 4.88 and 5.06, respectively) was recorded with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition.

4.1.8 Total dry matter production (g plant⁻¹)

The data on dry matter production recorded at different growth stages as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.7.

At 30 days, significant variation was not observed in the dry matter production between methods of establishment. Among the potassium levels, significantly higher total dry matter production was recorded with application of 37.5 kg K₂O ha⁻¹ (3.91 g plant⁻¹) compared to application of 25 kg K₂O ha⁻¹ (3.22 g plant⁻¹). However, it was on par with application of 50 kg K₂O ha⁻¹ (3.87 g plant⁻¹). Significant variation was not observed in the total dry matter production between times of application.

Table 4.7: Total dry matter (g plant⁻¹) in finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	Total dry matter at 30 days	Total dry matter at 60 days	Total dry matter at 90 days	Total dry matter at harvest	Treatments	Total dry matter at 30 days	Total dry matter at 60 days	Total dry matter at 90 days	Total dry matter at harvest
M ₁	3.59	19.34	34.86	38.69	M ₂ T ₁	3.65	22.81	39.33	44.28
M ₂	3.74	22.31	38.76	43.58	M ₂ T ₂	3.84	21.79	38.19	42.88
SEm±	0.06	0.23	0.20	0.20	SEm±	0.08	0.33	0.28	0.28
CD at 5%	NS	0.68	0.59	0.58	CD at 5%	NS	NS	NS	NS
Factor B (Potassium levels)									
K ₁	3.22	16.43	31.35	33.87	K ₁ T ₁	3.16	18.31	33.19	36.11
K ₂	3.91	23.22	39.85	45.09	K ₁ T ₂	3.87	14.55	29.51	31.64
K ₃	3.87	22.82	39.23	44.44	K ₂ T ₁	3.87	23.36	40.00	45.30
SEm±	0.07	0.28	0.25	0.24	K ₂ T ₂	3.87	23.08	39.69	44.88
CD at 5%	0.20	0.83	0.72	0.72	K ₃ T ₁	3.87	22.89	39.36	44.55
Factor C (Time of application)									
T ₁	3.65	21.52	37.52	41.99	SEm±	0.1	0.40	0.35	0.35
T ₂	3.68	20.13	36.09	40.28	CD at 5%	NS	1.18	1.02	1.01
SEm±	0.06	0.23	0.20	0.20	Factor A x Factor B x Factor C				
CD at 5%	NS	0.68	0.59	0.58	M ₁ K ₁ T ₁	3.23	16.19	30.56	33.03
Factor A x Factor B									
M ₁ K ₁	3.08	13.81	28.26	30.34	M ₁ K ₁ T ₂	2.93	11.43	25.97	27.65
M ₁ K ₂	3.87	22.32	38.51	43.19	M ₁ K ₂ T ₁	3.88	22.53	38.64	43.36
M ₁ K ₃	3.81	21.89	37.79	42.54	M ₁ K ₂ T ₂	3.86	22.11	38.37	43.03
M ₂ K ₁	3.36	19.05	34.44	37.40	M ₁ K ₃ T ₁	3.84	21.95	37.93	42.69
M ₂ K ₂	3.95	24.11	41.18	46.99	M ₁ K ₃ T ₂	3.79	21.84	37.66	42.39
M ₂ K ₃	3.92	23.76	40.66	46.33	M ₂ K ₁ T ₁	3.08	20.43	35.83	39.18
SEm±	0.10	0.40	0.35	0.35	M ₂ K ₁ T ₂	3.63	17.67	33.06	35.62
CD at 5%	NS	1.18	1.02	1.01	M ₂ K ₂ T ₁	3.97	24.18	41.36	47.25
Factor A x Factor C									
M ₁ T ₁	3.65	20.22	35.71	39.69	M ₂ K ₂ T ₂	3.93	24.05	41.00	46.74
M ₁ T ₂	3.53	18.46	34	37.69	M ₂ K ₃ T ₁	3.9	23.83	40.8	46.39
Factor B x Factor C									
					M ₂ K ₃ T ₂	3.94	23.68	40.51	46.27
					SEm±	0.14	0.57	0.49	0.49
					CD at 5%	NS	NS	NS	NS

30 days (30 DAS and 8 DAT), 60 days (60 DAS and 38 DAT), 90 days (90 DAS and 68 DAT)

DAS: days after sowing, DAT: days after transplanting,

NS: Non-significant

However, the total dry matter accumulation was higher with basal application (3.67 g plant⁻¹) compared to split application of potassium fertilizer (3.66 g plant⁻¹). All interaction effects are found to be non - significant for the total dry matter production at 30 days.

The data provided in Table 4.7, revealed that the transplanting method recorded significantly higher total dry matter production (22.31, 38.76 and 43.58 g plant⁻¹ at 60 days, 90 days and at harvest, respectively) compared to drill sown condition (19.34, 34.86 and 38.69 g plant⁻¹ at 60 days, 90 days and at harvest, respectively). Among the potassium levels, significantly higher total dry matter production was recorded with application of 37.5 kg K₂O ha⁻¹ (23.22, 39.85 and 45.09 g plant⁻¹ at 60 days, 90 days and at harvest, respectively) compared to application of 25 kg K₂O ha⁻¹ (16.43, 31.35 and 33.87 g plant⁻¹ at 60 days, 90 days and at harvest, respectively). However, it was on par with application of 50 kg K₂O ha⁻¹ (22.82, 39.23 and 44.44 g plant⁻¹ at 60 days, 90 days and at harvest, respectively). Time of application also influenced the total dry matter production, basal application of potassium fertilizer recorded significantly higher total dry matter production (21.52, 37.52 and 41.99 g plant⁻¹ at 60 days, 90 days and at harvest, respectively) compared to split application (20.13, 36.09 and 40.28 g plant⁻¹ at 60days, 90 days and at harvest, respectively).

Among the interactions methods of establishment × potassium levels and potassium levels × time of application observed significant effect. Transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly more dry matter production (24.11, 41.18 and 46.99 g plant⁻¹ at 60 days, 90 days and at harvest, respectively) and it was op par with the transplanting + application of 50 kg K₂O ha⁻¹ (23.76, 40.66 and 46.33 g plant⁻¹ at 60 days, 90 days and at harvest, respectively). Significantly lower total dry matter production was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (13.81, 28.26 and 30.34 g plant⁻¹ at 60 days, 90 days and at harvest, respectively).

Among the interactions of potassium levels × time of application, basal application of 37.5 kg K₂O ha⁻¹ recorded significantly superior total dry matter production (23.36, 40.00 and 45.30 g plant⁻¹ at 60 days, 90 days and at harvest, respectively) and it was on par with split application of 37.5 kg K₂O ha⁻¹ (23.08, 39.69 and 44.88 g plant⁻¹ at 60 days, 90 days and at harvest, respectively) followed by split / basal application of 50 kg K₂O ha⁻¹. Remaining all interaction effects is found to be non - significant at 60 days, 90 days and at harvest, respectively. However, numerically higher total dry matter production (24.18, 41.36 and 47.25 at 60 days, 90 days and at harvest, respectively) was recorded with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition.

4.2 Effect of methods of establishment, different potassium levels and time of application on yield and yield attributes of finger millet

Data on yield components *viz.*, number of ear heads per hill, number of fingers per ear head, grain yield (kg ha⁻¹), straw yield (kg ha⁻¹), harvest index and 1000 grain weight as influenced by method of establishment, different potassium levels and time of application are furnished in Table 4.8 and 4.9.

4.2.1 Number of ear heads hill⁻¹

The data on number of ear heads hill⁻¹ of finger millet as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.8.

At harvest, number of ear heads influenced due to methods of establishment, significantly higher number of ear heads was observed in transplanting method (4.28) compared to drill sown crop (4.06). Among the potassium levels, significantly higher number of ear heads was recorded with application of 37.5 kg K₂O ha⁻¹ (4.43) compared to application of 25 kg K₂O ha⁻¹ (3.68). However, it was on par with application of 50 kg K₂O ha⁻¹ (4.41). Time of application also influenced number of ear heads hill⁻¹, basal application of potassium fertilizer recorded significantly superior number of ear heads per hill (4.21) compared to application of potassium as 50 per cent basal and 50 per cent top dressing (4.15).

Among the interaction effects, potassium levels × time of application recorded significant difference. Basal application of 37.5 kg K₂O ha⁻¹ recorded significantly superior number of ear heads hill⁻¹ (4.4) and it was on par with split application of 37.5 kg K₂O ha⁻¹ (4.43) followed by split / basal application of 50 kg K₂O ha⁻¹. Significantly lower number of ear heads was recorded with split application of 25 kg K₂O ha⁻¹ (3.60). Remaining all interaction effects are found to be non significant. However, numerically higher number of ear heads was observed with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (4.55) and lower number of ear heads was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition (3.47) in the interaction of all the three factors.

4.2.2 Number of fingers earhead⁻¹

The data on number of fingers earhead⁻¹ as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.8.

At harvest, all the three factors showed significant variation. Significantly higher number of fingers earhead⁻¹ was observed in transplanting method (8.89) compared to drill sown (8.49). Significantly higher number of fingers earhead⁻¹ was recorded with application of 37.5 kg K₂O ha⁻¹ (9.04) compared to application of 25 kg

Table 4.8: Number of ear heads hill⁻¹, number of fingers earhead⁻¹ and test weight in finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	Number of finger ear head ⁻¹ at harvest	Number of ear heads hill ⁻¹ at harvest	Test weight (g)	Treatments	Number of finger ear head ⁻¹ at harvest	Number of ear heads hill ⁻¹ at harvest	Test weight (g)
	Factor A (Method of establishment)						
M ₁	8.49	4.06	3.01	M ₂ T ₁	8.94	4.31	3.19
M ₂	8.89	4.28	3.19	M ₂ T ₂	8.85	4.26	3.19
SEm±	0.02	0.007	0.03	SEm±	0.03	0.011	0.04
CD at 5%	0.07	0.022	0.08	CD at 5%	NS	NS	NS
	Factor B (Potassium levels)			Factor B x Factor C			
K ₁	8.06	3.68	2.89	K ₁ T ₁	8.25	3.77	8.37
K ₂	9.04	4.43	3.21	K ₁ T ₂	7.88	3.60	2.84
K ₃	8.97	4.41	3.21	K ₂ T ₁	9.06	4.44	3.21
SEm±	0.03	0.009	0.03	K ₂ T ₂	9.03	4.43	3.21
CD at 5%	0.09	0.027	0.09	K ₃ T ₁	8.99	4.41	3.19
	Factor C (Time of application)			K ₃ T ₂	8.95	4.41	3.22
T ₁	8.77	4.21	3.11	SEm±	0.04	0.013	0.04
T ₂	8.62	4.15	3.09	CD at 5%	0.12	0.038	NS
SEm±	0.02	0.007	0.03				
CD at 5%	0.07	0.022	NS	Factor A x Factor B x Factor C			
	Factor A x Factor B			M ₁ K ₁ T ₁	8.04	3.67	2.87
M ₁ K ₁	7.77	3.57	2.83	M ₁ K ₁ T ₂	7.50	3.47	2.78
M ₁ K ₂	8.89	4.32	3.11	M ₁ K ₂ T ₁	8.92	4.33	3.13
M ₁ K ₃	8.80	4.31	3.09	M ₁ K ₂ T ₂	8.87	4.32	3.08
M ₂ K ₁	8.36	3.80	2.95	M ₁ K ₃ T ₁	8.83	4.30	3.10
M ₂ K ₂	9.19	4.54	3.32	M ₁ K ₃ T ₂	8.77	4.29	3.09
M ₂ K ₃	9.14	4.51	3.31	M ₂ K ₁ T ₁	8.46	3.87	3.00
SEm±	0.04	0.013	0.04	M ₂ K ₁ T ₂	8.26	3.74	2.90
CD at 5%	0.12	NS	NS	M ₂ K ₂ T ₁	9.21	4.55	3.30
	Factor A x Factor C			M ₂ K ₂ T ₂	9.19	4.54	3.34
M ₁ T ₁	8.59	4.10	3.04	M ₂ K ₃ T ₁	9.15	4.51	3.28
M ₁ T ₂	8.38	4.03	2.98	M ₂ K ₃ T ₂	9.12	4.50	3.35
				SEm±	0.06	0.018	0.06
				CD at 5%	NS	NS	NS

NS: Non-significant

K₂O ha⁻¹ (8.06). However, it was on par with application of 50 kg K₂O ha⁻¹ (8.97). Basal application of potassium fertilizer recorded significantly superior number of fingers (8.77) compared to split application of potassium (8.62).

Among the interactions, methods of establishment × potassium levels and potassium levels × time of application showed significant difference. Transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly more number of fingers per ear head (9.19) and it was on par with the transplanting + application of 50 kg K₂O ha⁻¹ (9.14). Significantly less number of fingers per ear head was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (7.77). Among the potassium levels × time of application, application of 37.5 kg K₂O ha⁻¹ + basal application recorded significantly superior number of fingers per ear head (9.06) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (9.03) followed by basal/ split application of 50 kg K₂O ha⁻¹. Remaining all interaction effects are found to be non significant. However, in the interaction of all the three factors numerically higher number of fingers per ear head was recorded with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (9.21) and lower number of fingers per ear head was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition (7.5).

4.2.3 Test weight (g)

The data on test weight of finger millet as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.8.

Test weight influenced due to methods of establishment, test weight of finger millet was significantly higher in transplanting method (3.19 g) compared to drill sown method (3.01 g). Significantly higher test weight was recorded with the application of 37.5 kg K₂O ha⁻¹ (3.21 g) compared to application of 25 kg K₂O ha⁻¹ (2.89 g). Test weight was found to be non – significant for the times of application. However, numerically higher test weight was recorded with basal application of potassium (3.11 g) compared to split application (3.09 g). All interaction effects for the test weight are found to be non significant.

4.2.4 Grain yield (kg ha⁻¹)

The data on grain yield of finger millet as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.9.

Significant variation was observed in the grain yield between methods of establishment. Significantly higher grain yield was recorded with transplanting method (3,300 kg ha⁻¹) compared to drill sown method (3,000 kg ha⁻¹). Among the potassium levels, significantly higher grain yield was recorded with application of 37.5 kg K₂O ha⁻¹ (3,467 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹

(2,577 kg ha⁻¹). However, it was on par with application of 50 kg K₂O ha⁻¹ (3,411 kg ha⁻¹). Time of application also influenced the grain yield, basal application of potassium fertilizer recorded significantly higher grain yield (3,203 kg ha⁻¹) compared to split application (3,099 kg ha⁻¹).

Among the interaction effects, methods of establishment × potassium levels and potassium levels × time of application showed significant difference. Transplanting + application of 37.5 kg K₂O ha⁻¹ significantly recorded more grain yield (3,583 kg ha⁻¹) and it was on par with transplanting + 50 kg K₂O ha⁻¹ (3,529 kg ha⁻¹). Significantly lower grain yield was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (2,368 kg ha⁻¹). Among the interactions of potassium levels × time of application, 37.5 kg K₂O ha⁻¹ + basal application recorded significantly superior grain yield (3,482 kg ha⁻¹) and it was on par with split application of 37.5 kg K₂O ha⁻¹ (3,452 kg ha⁻¹) followed by split / basal application of 50 kg K₂O ha⁻¹. Remaining all interaction effects are found to be non significant. However, numerically the highest grain yield was recorded with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (3,589 kg ha⁻¹) and the lowest grain yield was recorded in split application of 25 kg K₂O ha⁻¹ under drill sown condition (2,266 kg ha⁻¹) among the interactions of all the three factors.

4.2.5 Straw yield (kg ha⁻¹)

The data on straw yield of finger millet as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.9.

Straw yield influenced due to methods of establishment, significantly highest straw yield was recorded in transplanting method (6,270 kg ha⁻¹) compared to drill sown method (5,989 kg ha⁻¹). Among the potassium levels, significantly higher straw yield was recorded with application of 37.5 kg K₂O ha⁻¹ (6,445 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹ (5,543 kg ha⁻¹). However, it was on par with application of 50 kg K₂O ha⁻¹ (6,399 kg ha⁻¹). Time of application also influenced the straw yield, basal application of potassium fertilizer recorded significantly higher straw yield (6,179 kg ha⁻¹) compared to split application (6,079).

Among the interaction effects, methods of establishment × potassium levels and potassium levels × time of application showed significant difference. Transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly highest straw yield (6,553 kg ha⁻¹) and it was on par with transplanting + 50 kg K₂O ha⁻¹ (6,506 kg ha⁻¹). Significantly lowest straw yield was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (5,335 kg ha⁻¹). Among the interactions of potassium levels × time of application, 37.5 kg K₂O ha⁻¹ + basal application recorded significantly superior straw yield (6,459 kg ha⁻¹) and it was on par with the split

Table 4.9: Grain yield, straw yield and harvest index of finger millet as influenced by method of establishment, different potassium levels and time of application

Treatments	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index	Treatments	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index
	Factor A (Method of establishment)						
M ₁	3,000	5,989	0.332	M ₂ T ₁	3,358	6,327	0.346
M ₂	3,300	6,270	0.344	M ₂ T ₂	3,240	6,214	0.341
SEM±	16.40	18.29	0.001	SEM±	23.19	25.87	0.001
CD at 5%	48.12	53.67	0.002	CD at 5%	NS	NS	NS
	Factor B (Potassium levels)			Factor B x Factor C			
K ₁	2,577	5,543	0.317	K ₁ T ₁	2,699	5,665	0.322
K ₂	3,467	6,445	0.350	K ₁ T ₂	2,455	5,421	0.311
K ₃	3,411	6,399	0.348	K ₂ T ₁	3,482	6,459	0.350
SEM±	20.09	22.40	0.001	K ₂ T ₂	3,452	6,432	0.349
CD at 5%	58.93	65.73	0.002	K ₃ T ₁	3,430	6,415	0.348
	Factor C (Time of application)			K ₃ T ₂	3,392	6,384	0.347
T ₁	3,203	6,179	0.340	SEM±	28.41	31.68	0.001
T ₂	3,099	6,079	0.336	CD at 5%	83.35	92.95	0.003
SEM±	16.40	18.29	0.001	Factor A x Factor B x Factor C			
CD at 5%	48.12	53.67	0.002	M ₁ K ₁ T ₁	2,471	5,437	0.312
	Factor A x Factor B			M ₁ K ₁ T ₂	2,266	5,233	0.302
M ₁ K ₁	2,368	5,335	0.307	M ₁ K ₂ T ₁	3,375	6,358	0.347
M ₁ K ₂	3,351	6,338	0.346	M ₁ K ₂ T ₂	3,327	6,317	0.345
M ₁ K ₃	3,293	6,293	0.344	M ₁ K ₃ T ₁	3,302	6,302	0.344
M ₂ K ₁	2,784	5,751	0.326	M ₁ K ₃ T ₂	3,284	6,284	0.343
M ₂ K ₂	3,583	6,553	0.353	M ₂ K ₁ T ₁	2,926	5,893	0.332
M ₂ K ₃	3,529	6,506	0.352	M ₂ K ₁ T ₂	2,643	5,609	0.320
SEM±	28.41	31.68	0.001	M ₂ K ₂ T ₁	3,589	6,559	0.354
CD at 5%	83.35	92.95	0.003	M ₂ K ₂ T ₂	3,577	6,547	0.353
	Factor A x Factor C			M ₂ K ₃ T ₁	3,558	6,528	0.353
M ₁ T ₁	3,049	6,032	0.334	M ₂ K ₃ T ₂	3,501	6,484	0.351
M ₁ T ₂	2,959	5,944	0.330	SEM±	40.18	44.813	0.002
	NS: Non-significant			CD at 5%	NS	NS	NS

application of 37.5 kg K₂O ha⁻¹ (6,432 kg ha⁻¹). Significantly lowest grain yield was recorded with application of 25 kg K₂O ha⁻¹ + split application (5,421 kg ha⁻¹). Remaining all interaction effects are found to be non significant. However, numerically higher straw yield was recorded with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (6,559 kg ha⁻¹) and lowest straw yield was recorded under split application of 25 kg ha⁻¹ potassium under drill sown condition (5,233 kg ha⁻¹) among the interactions of all the three factors.

4.2.6 Harvest index

The data on harvest index of finger millet as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.9.

Significantly higher harvest index was recorded with transplanting method (0.344) compared to drill sown method (0.332). Among the potassium levels, recorded significantly higher straw yield was recorded with application of 37.5 kg K₂O ha⁻¹ (0.350) compared to application of 25 kg K₂O ha⁻¹ (0.317). However, it was on par with application of 50 kg ha⁻¹ potassium (0.348). Basal application of potassium fertilizer significantly recorded higher harvest index (0.340) compared to split application (0.336).

Among the interaction effects, methods of establishment × potassium levels and potassium levels × time of application showed significant difference. Transplanting + application of 37.5 kg K₂O ha⁻¹ recorded significantly higher harvest index (0.353) and it was on par with the transplanting + application of 50 kg K₂O ha⁻¹ (0.352). Significantly the lowest harvest index was recorded with drill sown + application of 25 kg K₂O ha⁻¹ (0.307). Among the interactions of potassium levels × time of application, 37.5 kg K₂O ha⁻¹ + basal application significantly recorded superior harvest index (0.350) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (0.349). Significantly the lowest harvest index was recorded with split application of 25 kg K₂O ha⁻¹ (0.311). Remaining all interaction effects are found to be non significant.

4.3 Nutrient uptake

Data pertaining to uptake of nitrogen, phosphorus and potassium as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.10 to 4.12b.

4.3.1 Nitrogen uptake (kg ha⁻¹)

4.3.1.1 Nitrogen uptake by straw (kg ha⁻¹)

At harvest, significantly higher nitrogen uptake by straw was recorded with transplanting method (63.19 kg ha⁻¹) compared to drill sown method (58.10 kg ha⁻¹).

Table 4.10: Nitrogen uptake by finger millet (kg ha⁻¹) at harvest as influenced by method of establishment, different potassium levels and time of application

Treatments	Straw	Grain	Total uptake	Treatments	Straw	Grain	Total uptake
	Factor A (Method of establishment)						
M ₁	58.10	20.11	78.22	M ₂ T ₁	63.99	23.79	87.69
M ₂	63.19	23.34	86.45	M ₂ T ₂	62.39	22.89	85.20
SEM±	0.33	0.19	0.52	SEM±	0.47	0.27	0.73
CD at 5%	0.97	0.56	1.52	CD at 5%	NS	NS	NS
	Factor B (Potassium levels)			Factor B x Factor C			
K ₁	52.52	16.65	69.17	K ₁ T ₁	53.92	17.54	71.45
K ₂	65.27	24.59	89.84	K ₁ T ₂	51.12	15.76	66.88
K ₃	64.15	23.93	88.00	K ₂ T ₁	65.64	24.72	90.30
SEM±	0.41	0.24	0.63	K ₂ T ₂	64.91	24.46	89.37
CD at 5%	1.19	0.69	1.86	K ₃ T ₁	64.49	24.10	88.57
	Factor C (Time of application)			K ₃ T ₂	63.81	23.77	87.42
T ₁	61.35	22.12	83.44	SEM±	0.57	0.33	0.89
T ₂	59.95	21.33	81.23	CD at 5%	NS	NS	NS
SEM±	0.33	0.19	0.52	Factor A x Factor B x Factor C			
CD at 5%	0.97	0.56	1.52	M ₁ K ₁ T ₁	51.06	15.72	66.78
	Factor A x Factor B			M ₁ K ₁ T ₂	48.79	14.32	63.11
M ₁ K ₁	49.92	15.02	64.94	M ₁ K ₂ T ₁	63.17	23.19	86.46
M ₁ K ₂	62.74	23.01	85.79	M ₁ K ₂ T ₂	62.31	22.82	85.13
M ₁ K ₃	61.65	22.32	83.92	M ₁ K ₃ T ₁	61.89	22.44	84.33
M ₂ K ₁	55.11	18.28	73.39	M ₁ K ₃ T ₂	61.42	22.19	83.51
M ₂ K ₂	67.81	26.18	93.88	M ₂ K ₁ T ₁	56.78	19.35	76.13
M ₂ K ₃	66.64	25.55	92.07	M ₂ K ₁ T ₂	53.45	17.21	70.65
SEM±	0.57	0.33	0.89	M ₂ K ₂ T ₁	68.11	26.25	94.15
CD at 5%	NS	NS	NS	M ₂ K ₂ T ₂	67.51	26.11	93.62
	Factor A x Factor C			M ₂ K ₃ T ₁	67.08	25.75	92.81
M ₁ T ₁	58.70	20.45	79.19	M ₂ K ₃ T ₂	66.20	25.34	91.33
M ₁ T ₂	57.51	19.78	77.25	SEM±	0.81	0.47	1.27
	NS: Non-significant			CD at 5%	NS	NS	NS

Among the potassium levels, recorded significantly higher uptake of nitrogen was recorded with application of 37.5 kg K₂O ha⁻¹ (65.27 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹ (52.52 kg ha⁻¹). However, it was on par with the application of 50 kg K₂O ha⁻¹ (64.15 kg ha⁻¹). Nitrogen uptake by straw influenced significantly due to time of application, basal application of potassium fertilizer recorded significantly higher nitrogen uptake by straw (61.36 kg ha⁻¹) compared to split application (59.90 kg ha⁻¹). All interaction effects for the nitrogen uptake by the straw are found to be non significant. However, numerically highest nitrogen uptake by the straw was observed with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (68.11 kg ha⁻¹) and lowest nitrogen uptake by the straw was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition (48.79 kg ha⁻¹).

4.3.1.2 Nitrogen uptake by grain (kg ha⁻¹)

At harvest, all the three factors showed significant variation. Significantly higher nitrogen uptake by grain was recorded with transplanting method (23.34 kg ha⁻¹) compared to drill sown (20.11 kg ha⁻¹). Among the potassium levels, recorded significantly higher uptake of nitrogen was recorded with application of 37.5 kg K₂O ha⁻¹ (24.59 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹ (16.65 kg ha⁻¹). However, it was on par with the application of 50 kg ha⁻¹ of potassium (23.93 kg ha⁻¹). Nitrogen uptake by grain influenced significantly due to time of application, basal application of potassium fertilizer recorded significantly higher nitrogen uptake by grain (22.12 kg ha⁻¹) compared to split application (21.33 kg ha⁻¹). All interaction effects for the nitrogen uptake by the grain are found to be non-significant. However, numerically the highest nitrogen uptake by the grain was observed with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (26.25 kg ha⁻¹) and the lowest nitrogen uptake by the grain was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition (14.32 kg ha⁻¹) in the interaction of all the three factors.

4.3.1.3 Total nitrogen uptake (kg ha⁻¹)

At harvest, transplanting method significantly recorded higher total nitrogen uptake (86.45) compared to drill sowed (78.22 kg ha⁻¹). Among the potassium levels, recorded significantly higher total uptake of nitrogen was recorded with application of 37.5 kg K₂O ha⁻¹ (89.84) compared to application of 25 kg K₂O ha⁻¹ (69.17 kg ha⁻¹). However, it was on par with the application of 50 kg ha⁻¹ of potassium (88.00 kg ha⁻¹). Total nitrogen uptake influenced significantly due to time of application, basal application of potassium fertilizer recorded significantly higher total nitrogen uptake (83.44 kg ha⁻¹) compared to split application (81.23 kg ha⁻¹). All interaction effects are found to be non –significant for the total nitrogen uptake. In interaction of three factors, the highest total nitrogen uptake (94.15 kg ha⁻¹) was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition and the lowest total

nitrogen uptake (63.11 kg ha^{-1}) was observed with application of $25 \text{ kg K}_2\text{O ha}^{-1}$ as split application under drill sown condition.

4.3.2 Phosphorous uptake (kg ha^{-1})

4.3.2.1 Phosphorous uptake by straw (kg ha^{-1})

At harvest, significantly higher phosphorous uptake by straw was recorded in transplanting method (23.47 kg ha^{-1}) compared to drill sown method (21.29 kg ha^{-1}). Among the potassium levels, recorded significantly higher total uptake of phosphorous was recorded with application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ (24.37 kg ha^{-1}) compared to application of $25 \text{ kg K}_2\text{O ha}^{-1}$ (18.76 kg ha^{-1}). However, it was on par with the application of $50 \text{ kg K}_2\text{O ha}^{-1}$ (24.00 kg ha^{-1}). Phosphorous uptake by straw influenced significantly due to time of application, basal application of potassium fertilizer recorded significantly higher phosphorous uptake by straw (22.61 kg ha^{-1}) compared to split application (22.15 kg ha^{-1}). All interaction effects for the phosphorous uptake by the straw are found to be non significant. However, numerically the highest phosphorous uptake by the straw was observed with basal application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ under transplanted condition (25.37 kg ha^{-1}) and the lowest phosphorous uptake by the straw was recorded with split application of $25 \text{ kg K}_2\text{O ha}^{-1}$ under drill sown condition (17.21 kg ha^{-1}).

4.3.2.2 Phosphorous uptake by grain (kg ha^{-1})

Significant variation was observed between the methods of establishment for phosphorous uptake by grain. Significantly higher phosphorous uptake by grain was recorded with transplanting method (23.47 kg ha^{-1}) compared to drill sown method (21.29 kg ha^{-1}). Among the potassium levels, recorded significantly higher uptake of phosphorous were recorded with application of $37.5 \text{ kg K}_2\text{O ha}^{-1}$ (8.41 kg ha^{-1}) compared to application of $25 \text{ kg K}_2\text{O ha}^{-1}$ (5.26). However, it was on par with the application of $50 \text{ kg K}_2\text{O ha}^{-1}$ (8.13 kg ha^{-1}). Phosphorous uptake by grain influenced significantly due to time of application, basal application of potassium fertilizer recorded significantly higher phosphorous uptake by grain (7.41 kg ha^{-1}) compared to split application as 50 per cent at sowing/transplanting and remaining 50 per cent at 35 DAS/ 30 DAT (7.12 kg ha^{-1}). All interaction effects for the phosphorous uptake by the grain are found to be non significant. However, the highest phosphorous uptake by the grain was observed with basal application of 37.5 kg ha^{-1} of potassium under transplanted condition (9.05 kg ha^{-1}) and the lowest phosphorous uptake by the grain was recorded with split application of $25 \text{ kg K}_2\text{O ha}^{-1}$ under drill sown condition (4.39 kg ha^{-1}) in the interaction of all the three factors.

4.3.2.3 Total phosphorous uptake (kg ha^{-1})

At harvest, significantly higher total phosphorous uptake was recorded with transplanting method (31.34 kg ha^{-1}) compared to drill sown method (27.89 kg ha^{-1}).

Table 4.11: Phosphorous uptake by finger millet (kg ha⁻¹) at harvest as influenced by method of establishment, different potassium levels and time of application

Treatments	Straw	Grain	Total uptake	Treatments	Straw	Grain	Total uptake
	Factor A (Method of establishment)						
M ₁	21.29	6.64	27.89	M ₂ T ₁	23.77	8.08	31.84
M ₂	23.47	7.90	31.34	M ₂ T ₂	23.16	7.71	30.83
SEM±	0.14	0.08	0.20	SEM±	0.19	0.11	0.3
CD at 5%	0.4	0.23	0.60	CD at 5%	NS	NS	NS
	Factor B (Potassium levels)			Factor B x Factor C			
K ₁	18.76	5.26	24.03	K ₁ T ₁	19.24	5.55	24.80
K ₂	24.37	8.41	32.77	K ₁ T ₂	18.29	4.97	23.26
K ₃	24.00	8.13	32.05	K ₂ T ₁	24.49	8.46	32.94
SEM±	0.17	0.096	0.25	K ₂ T ₂	24.25	8.35	32.60
CD at 5%	0.49	0.28	0.73	K ₃ T ₁	24.09	8.21	32.25
	Factor C (Time of application)			K ₃ T ₂	23.91	8.05	31.84
T ₁	22.61	7.41	30.00	SEM±	0.24	0.14	0.35
T ₂	22.15	7.12	29.23	CD at 5%	NS	NS	NS
SEM±	0.14	0.08	0.20	Factor A x Factor B x Factor C			
CD at 5%	0.4	0.23	0.6	M ₁ K ₁ T ₁	17.62	4.68	22.31
	Factor A x Factor B			M ₁ K ₁ T ₂	17.21	4.39	21.60
M ₁ K ₁	17.42	4.54	21.95	M ₁ K ₂ T ₁	23.61	7.88	31.49
M ₁ K ₂	23.42	7.81	31.23	M ₁ K ₂ T ₂	23.24	7.73	30.97
M ₁ K ₃	23.02	7.58	30.49	M ₁ K ₃ T ₁	23.10	7.66	30.65
M ₂ K ₁	20.11	5.99	26.10	M ₁ K ₃ T ₂	22.94	7.49	30.34
M ₂ K ₂	25.31	9.01	34.31	M ₂ K ₁ T ₁	20.86	6.43	27.29
M ₂ K ₃	24.98	8.69	33.70	M ₂ K ₁ T ₂	19.36	5.55	24.91
SEM±	0.24	0.14	0.35	M ₂ K ₂ T ₁	25.37	9.05	34.39
CD at 5%	NS	NS	NS	M ₂ K ₂ T ₂	25.25	8.97	34.23
	Factor A x Factor C			M ₂ K ₃ T ₁	25.08	8.77	33.85
M ₁ T ₁	21.44	6.74	28.15	M ₂ K ₃ T ₂	24.87	8.60	33.34
M ₁ T ₂	21.13	6.54	27.64	SEM±	0.33	0.19	0.5
				CD at 5%	NS	NS	NS

NS: Non-significant

Among the potassium levels, recorded significantly higher total phosphorous uptake was recorded with application of 37.5 kg K₂O ha⁻¹ (32.77 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹ (32.05 kg ha⁻¹). However, it was on par with the application of 50 kg K₂O ha⁻¹ (24.03 kg ha⁻¹). Total phosphorous uptake influenced significantly due to time of application, basal application of potassium fertilizer recorded significantly higher total phosphorous uptake (30.00 kg ha⁻¹) compared to split application (29.23 kg ha⁻¹). All interaction effects for the total phosphorous uptake are found to be non significant. However, numerically the highest total phosphorous uptake was observed with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (34.39 kg ha⁻¹) and the lowest total phosphorous uptake was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition (21.60 kg ha⁻¹).

4.3.3 Potassium uptake (kg ha⁻¹)

4.3.3.1 Potassium uptake by straw different stages of crop growth (kg ha⁻¹)

At 30 days, significant variation was not observed in the potassium uptake due to methods of establishment and time of application. Among the potassium levels, application of 37.5 kg K₂O ha⁻¹ recorded significantly higher potassium uptake by straw (34.99 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹ (29.24 kg ha⁻¹). However, it was on par with the 50 kg K₂O ha⁻¹ (34.56 kg ha⁻¹). All interaction effects are found to be non - significant for the potassium uptake at 30 days.

The data provided in Table 4.11a, revealed that the transplanting method significantly recorded higher potassium uptake (41.09 and 45.70 kg ha⁻¹ at 60 days and 90 days, respectively) compared to drill sown method (37.88 and 42.63 kg ha⁻¹ at 60 days and 90 days, respectively). Significantly higher potassium uptake was recorded with application of 37.5 kg K₂O ha⁻¹ (42.49 and 47.15 kg ha⁻¹ at 60 days and 90 days, respectively) compared to application of 25 kg K₂O ha⁻¹ (33.88 and 38.58 kg ha⁻¹ at 60 days and 90 days, respectively). However, it was on par with the application of 50 kg K₂O ha⁻¹ (42.09 and 46.76 kg ha⁻¹ at 60 days and 90 days, respectively). Basal application of potassium fertilizer significantly recorded higher potassium uptake (39.92 and 44.59 kg ha⁻¹ at 60 days and 90 days, respectively) compared to split application (39.05 and 43.74 kg ha⁻¹ at 60 days and 90 days, respectively).

Among the interaction effects, potassium levels × time of application showed significant effect. Basal application of 37.5 kg K₂O ha⁻¹ recorded significantly higher potassium uptake (42.59 and 47.25 kg ha⁻¹ at 60 days and 90 days, respectively) and it was on par with split application of 37.5 kg K₂O ha⁻¹ (42.38 and 47.05 kg ha⁻¹ at 60 and 90 days, respectively). Significantly lower potassium uptake was recorded with split application of 25 kg K₂O ha⁻¹ (32.81 and 37.53 kg ha⁻¹ at 60 days and 90 days,

Table 4.12a: Potassium uptake by finger millet at different growth stages as influenced by method of establishment, different potassium level

Treatments	Potassium up take by the crop(kg ha ⁻¹)									
	Straw		Straw		Straw		Straw		Straw	
	At 30 days	At 60 days	At 60 days	At 90 days	Treatments	At 30 days	At 60 days	At 30 days	At 60 days	At 90 days
	Factor A (Method of establishment)									
M ₁	32.73	37.88		42.63	M ₂ T ₁	33.41	41.58		46.17	
M ₂	33.12	41.09		45.70	M ₂ T ₂	32.84	40.61		45.23	
SEm±	0.43	0.16		0.10	SEM±	0.61	0.23		0.14	
CD at 5%	NS	0.47		0.30	CD at 5%	NS	NS		NS	
	Factor B (Potassium levels)									
K ₁	29.24	33.88		38.58	K ₁ T ₁	29.98	34.95		39.63	
K ₂	34.99	42.49		47.15	K ₁ T ₂	28.50	32.81		37.53	
K ₃	34.56	42.09		46.76	K ₂ T ₁	35.05	42.59		47.25	
SEm±	0.52	0.198		0.12	K ₂ T ₂	34.93	42.38		47.05	
CD at 5%	1.54	0.58		0.36	K ₃ T ₁	34.71	42.22		46.89	
	Factor C (Time of application)									
T ₁	33.25	39.92		44.59	SEM±	0.74	0.28		0.18	
T ₂	32.61	39.05		43.74	CD at 5%	NS	0.82		0.52	
SEm±	0.43	0.16		0.10	Factor A x Factor B x Factor C					
CD at 5%	NS	0.47		0.30	M ₁ K ₁ T ₁	29.27	33.07		37.71	
	Factor A x Factor B									
M ₁ K ₁	28.50	32.14		36.78	M ₁ K ₁ T ₂	27.74	31.22		35.85	
M ₁ K ₂	35.15	40.93		45.73	M ₁ K ₂ T ₁	35.32	41.09		45.86	
M ₁ K ₃	34.55	40.55		45.37	M ₁ K ₂ T ₂	34.97	40.78		45.59	
M ₂ K ₁	29.97	35.61		40.38	M ₁ K ₃ T ₁	34.67	40.63		45.45	
M ₂ K ₂	34.84	44.04		48.57	M ₁ K ₃ T ₂	34.43	40.47		45.29	
M ₂ K ₃	34.57	43.64		48.15	M ₂ K ₁ T ₁	30.69	36.84		41.54	
SEm±	0.74	0.28		0.18	M ₂ K ₁ T ₂	29.25	34.39		39.21	
CD at 5%	NS	NS		NS	M ₂ K ₂ T ₁	34.78	44.10		48.65	
	Factor A x Factor C									
M ₁ T ₁	33.08	38.26		43.01	M ₂ K ₂ T ₂	34.89	43.97		48.50	
M ₁ T ₂	32.38	37.49		42.24	M ₂ K ₃ T ₁	34.76	43.82		48.33	
	Factor B x Factor C									
	Factor C x Factor A									
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respectively). Remaining all interaction effects is found to be non - significant at 60 days and 90days. In interaction of all the three factors, the highest potassium uptake was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition (44.10 and 48.65 kg ha⁻¹ at 60 days and 90 days, respectively) and the lowest potassium uptake (31.22 and 35.85 kg ha⁻¹ at 60 days and 90 days, respectively) was observed with split application of 25 kg K₂O ha⁻¹ under drill sown condition.

4.3.3.2 Potassium uptake by straw at harvest (kg ha⁻¹)

Significant variation was observed between the methods of establishment. Significantly transplanting method recorded higher potassium uptake by straw (52.04 kg ha⁻¹) compared to drill sown method (48.83 kg ha⁻¹). Among the potassium levels, significantly higher potassium uptake was recorded with application of 37.5 kg K₂O ha⁻¹ (53.77 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹ (44.23 kg ha⁻¹). However, it was on par with the application of 50 kg K₂O ha⁻¹ (53.29 kg ha⁻¹). Potassium uptake by straw influenced significantly due to time of application, basal application of potassium fertilizer significantly recorded higher potassium uptake by straw (50.93 kg ha⁻¹) compared to split application (49.93).

Among the interactions, potassium levels × time of application showed significant effect. 37.5 kg K₂O ha⁻¹ + basal application significantly recorded more potassium uptake by the straw (53.91 kg ha⁻¹) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (53.63 kg ha⁻¹) followed by split/ basal application of 50 kg K₂O ha⁻¹. Significantly lowest potassium uptake by straw was recorded with split application of 25 kg ha⁻¹ potassium (43.04 kg ha⁻¹). Remaining all interaction effects is found to be non – significant for the potassium uptake by the straw. However, the highest potassium uptake by the straw was observed with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition (55.29 kg ha⁻¹) and the lowest potassium uptake by the straw was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition (41.26 kg ha⁻¹).

4.3.3.2 Potassium uptake by grain at harvest (kg ha⁻¹)

Significant variation was observed between the methods of establishment. Significantly higher potassium uptake by the grain was recorded with transplanted condition (15.03 kg ha⁻¹) compared to drill sown condition (13.18 kg ha⁻¹). Among the potassium levels, significantly higher potassium uptake was recorded with application of 37.5 kg K₂O ha⁻¹ (15.82) compared to application 25 kg K₂O ha⁻¹ (11.00 kg ha⁻¹). However, it was on par with the application of 50 kg K₂O ha⁻¹ (15.60 kg ha⁻¹). Potassium uptake by grain influenced significantly due to time of application, basal application of potassium fertilizer significantly recorded higher potassium uptake

Table 4.12b: Potassium uptake by finger millet (kg ha⁻¹) at harvest as influenced by method of establishment, different potassium levels and time of application

Treatments	Straw	Grain	Total uptake	Treatments	Straw	Grain	Total uptake
	Factor A (Method of establishment)						
M ₁	48.83	13.18	62.00	M ₂ T ₁	52.61	15.29	67.88
M ₂	52.04	15.03	67.05	M ₂ T ₂	51.46	14.76	66.21
SEm±	0.15	0.06	0.20	SEm±	0.21	0.09	0.28
CD at 5%	0.44	0.19	0.59	CD at 5%	NS	NS	NS
	Factor B (Potassium levels)				Factor B x Factor C		
K ₁	44.23	11.00	55.13	K ₁ T ₁	45.43	11.50	56.93
K ₂	53.77	15.82	69.57	K ₁ T ₂	43.04	10.30	53.33
K ₃	53.29	15.60	68.87	K ₂ T ₁	53.91	15.88	69.75
SEm±	0.19	0.08	0.25	K ₂ T ₂	53.63	15.77	69.40
CD at 5%	0.55	0.23	0.72	K ₃ T ₁	53.44	15.67	69.10
	Factor C (Time of application)			K ₃ T ₂	53.13	15.51	68.63
T ₁	50.93	14.35	65.26	SEm±	0.26	0.11	0.35
T ₂	49.93	13.86	63.79	CD at 5%	0.77	0.32	1.02
SEm±	0.15	0.06	0.20		Factor A x Factor B x Factor C		
CD at 5%	0.44	0.19	0.59	M ₁ K ₁ T ₁	43.20	10.42	53.62
	Factor A x Factor B			M ₁ K ₁ T ₂	41.26	9.37	50.63
M ₁ K ₁	42.23	9.89	52.13	M ₁ K ₂ T ₁	52.53	15.03	67.54
M ₁ K ₂	52.34	14.96	67.29	M ₁ K ₂ T ₂	52.16	14.88	67.04
M ₁ K ₃	52.00	14.70	66.59	M ₁ K ₃ T ₁	52.00	14.78	66.74
M ₂ K ₁	46.23	11.90	58.14	M ₁ K ₃ T ₂	51.80	14.63	66.43
M ₂ K ₂	55.20	16.69	71.85	M ₂ K ₁ T ₁	47.66	12.58	60.24
M ₂ K ₃	54.68	16.48	71.15	M ₂ K ₁ T ₂	44.81	11.22	56.03
SEm±	0.26	0.11	0.35	M ₂ K ₂ T ₁	55.29	16.73	71.95
CD at 5%	NS	NS	NS	M ₂ K ₂ T ₂	55.10	16.66	71.76
	Factor A x Factor C			M ₂ K ₃ T ₁	54.89	16.57	71.46
M ₁ T ₁	49.245	13.41	62.64	M ₂ K ₃ T ₂	54.47	16.40	70.84
M ₁ T ₂	48.406	12.96	61.37	SEm±	0.37	0.16	0.49
				CD at 5%	NS	NS	NS

NS: Non-significant

by grain (14.35 kg ha⁻¹) compared to split application as 50% at sowing/transplanting and remaining 50% at 35 DAS/ 30 DAT (13.86 kg ha⁻¹).

Among the interactions, potassium levels × time of application recorded significant effect. Basal application of 37.5 kg K₂O ha⁻¹ significantly recorded more potassium uptake by the grain (15.88 kg ha⁻¹) and it was on par with the split application of 37.5 kg K₂O ha⁻¹ (15.77 kg ha⁻¹) followed by split/ basal application of 50 kg K₂O ha⁻¹. Significantly lowest potassium uptake was recorded with the split application of 25 kg ha⁻¹ potassium (10.30 kg ha⁻¹). Remaining all interaction effects is found to be non – significant for the potassium uptake by the grain. However, the highest potassium uptake by the grain was observed with basal application of 37.5 kg ha⁻¹ of potassium under transplanted condition (16.73 kg ha⁻¹) and the lowest potassium uptake by the grain was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition (15.03 kg ha⁻¹).

4.3.3.2 Total potassium uptake (kg ha⁻¹)

At harvest, total potassium uptake influenced significantly due to methods of establishment. Transplanting method significantly recorded higher total potassium uptake (67.05 kg ha⁻¹) compared to drill sown method (62.00 kg ha⁻¹). Among the potassium levels, significantly higher total potassium uptake was recorded with application of 37.5 kg ha⁻¹ potassium (69.57 kg ha⁻¹) compared to application of 25 kg K₂O ha⁻¹ (55.13 kg ha⁻¹). However, it was on par with the application of 50 kg ha⁻¹ potassium (68.87 kg ha⁻¹). Total potassium uptake influenced significantly due to time of application, basal application of potassium fertilizer significantly recorded higher total potassium uptake (65.26 kg ha⁻¹) compared to split application (63.79 kg ha⁻¹).

Among the interactions, potassium levels × time of application showed significant effect. Basal application of 37.5 kg ha⁻¹ potassium significantly recorded higher total potassium uptake (69.75 kg ha⁻¹) and it was on par with the split application of 37.5 kg ha⁻¹ potassium (69.40 kg ha⁻¹). Remaining all interaction effects was found to be non - significant. In interaction of all the three factors, the highest total potassium uptake (71.95 kg ha⁻¹) was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose in transplanted condition and the lowest total potassium uptake (50.63 kg ha⁻¹) was observed with application of 25 kg K₂O ha⁻¹ as split dose under drill sown condition.

4.4 Chemical properties and nutrient status of soil after harvest of crop

4.4.1 Chemical properties

Data on soil organic carbon, electrical conductivity and soil pH after harvest of finger millet as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.13.

Table 4.13: Soil chemical properties after harvest of the crop as influenced by method of establishment, different potassium levels and time of application

Treatments	EC (dSm ⁻¹)	pH	OC (%)	Treatments	EC (dSm ⁻¹)	pH	OC (%)
	Factor A (Method of establishment)						
M ₁	0.45	5.64	0.37	M ₂ T ₁	0.44	5.40	0.37
M ₂	0.46	5.45	0.38	M ₂ T ₂	0.48	5.49	0.38
SEm±	0.02	0.13	0.01	SEm±	0.03	0.18	0.015
CD at 5%	NS	NS	NS	CD at 5%	NS	NS	NS
	Factor B (Potassium levels)				Factor B x Factor C		
K ₁	0.46	5.57	0.37	K ₁ T ₁	0.44	5.65	0.37
K ₂	0.42	5.63	0.37	K ₁ T ₂	0.48	5.49	0.38
K ₃	0.49	5.43	0.37	K ₂ T ₁	0.44	5.66	0.37
SEm±	0.02	0.15	0.013	K ₂ T ₂	0.41	5.59	0.38
CD at 5%	NS	NS	NS	K ₃ T ₁	0.51	5.51	0.36
	Factor C (Time of application)			K ₃ T ₂	0.47	5.35	0.37
T ₁	0.46	5.61	0.37	SEm±	0.03	0.22	0.02
T ₂	0.45	5.48	0.38	CD at 5%	NS	NS	NS
SEm±	0.02	0.13	0.01		Factor A x Factor B x Factor C		
CD at 5%	NS	NS	NS	M ₁ K ₁ T ₁	0.42	5.87	0.35
	Factor A x Factor B			M ₁ K ₁ T ₂	0.42	5.46	0.38
M ₁ K ₁	0.42	5.66	0.36	M ₁ K ₂ T ₁	0.46	5.84	0.38
M ₁ K ₂	0.43	5.69	0.38	M ₁ K ₂ T ₂	0.41	5.54	0.38
M ₁ K ₃	0.51	5.56	0.36	M ₁ K ₃ T ₁	0.56	5.73	0.36
M ₂ K ₁	0.51	5.48	0.38	M ₁ K ₃ T ₂	0.47	5.39	0.37
M ₂ K ₂	0.41	5.57	0.37	M ₂ K ₁ T ₁	0.46	5.43	0.39
M ₂ K ₃	0.47	5.29	0.37	M ₂ K ₁ T ₂	0.55	5.53	0.38
SEm±	0.03	0.22	0.02	M ₂ K ₂ T ₁	0.42	5.48	0.36
CD at 5%	NS	NS	NS	M ₂ K ₂ T ₂	0.40	5.65	0.38
	Factor A x Factor C			M ₂ K ₃ T ₁	0.46	5.29	0.37
M ₁ T ₁	0.48	5.81	0.36	M ₂ K ₃ T ₂	0.48	5.30	0.38
M ₁ T ₂	0.43	5.46	0.38	SEm±	0.05	0.31	0.03
				CD at 5%	NS	NS	NS

NS: Non-significant

4.4.1.1 Organic carbon (%)

Method of establishment, different potassium levels and time of application and their interactions had no significant difference on soil organic carbon after harvest of the crop. However, the organic carbon ranged from the 0.35 per cent to 0.40 per cent.

4.4.1.2 Electrical conductivity ($d\text{ Sm}^{-1}$)

Electrical conductivity in soil after harvest of finger millet did not showed significant difference in the method of establishment, different potassium levels and time of application and their interactions.

4.4.1.3 pH

Method of establishment, different potassium levels and times of application and their interactions had no significant difference on soil pH after harvest of the crop. However, the pH ranged from the 5.87 to 5.29.

4.4.2 Soil nutrient status after harvest

Data pertaining to available nutrients in the soil *viz.*, nitrogen, phosphorous and potassium after harvest of finger millet as influenced by method of establishment, different potassium levels and time of application are presented in Table 4.14.

4.4.2.1 Available nitrogen

Available nitrogen influenced significantly due to methods of establishment. Available nitrogen after harvest of the crop was significantly lower in the transplanting method ($163.07\text{ kg N ha}^{-1}$) compared to the drill sown condition ($182.65\text{ kg N ha}^{-1}$). Among the potassium levels, significantly higher available nitrogen in soil was recorded with application of $25\text{ kg K}_2\text{O ha}^{-1}$ ($205.93\text{ kg N ha}^{-1}$) compared to application of $37.5\text{ kg K}_2\text{O ha}^{-1}$ ($145.30\text{ kg N ha}^{-1}$). Significant variation was not observed in the available nitrogen between times of application. However, the available nitrogen was higher with split application of potassium fertilizer ($179.80\text{ kg N ha}^{-1}$) compared to basal application of potassium ($165.93\text{ kg N ha}^{-1}$). All interaction effects are found to be non - significant for the available nitrogen after harvest of the crop. In the interaction of all the three factors available nitrogen in soil was highest with $25\text{ kg K}_2\text{O ha}^{-1}$ application as split under drill sown condition ($125.44\text{ kg N ha}^{-1}$) and lowest available nitrogen was recorded with basal application of $37.5\text{ kg K}_2\text{O ha}^{-1}$ under transplanted condition ($217.43\text{ kg N ha}^{-1}$).

4.4.2.2 Available phosphorous

All the factors showed significant difference for available phosphorous in the soil. Available phosphorous after harvest of the crop was significantly recorded lowest under transplanted condition ($54.81\text{ kg P}_2\text{O}_5\text{ ha}^{-1}$) compared to drill sown

Table 4.14: Soil nutrient status after harvest of the crop as influenced by method of establishment, different potassium levels and time of application

Treatments	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	Treatments	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)
	Factor A (Method of establishment)						
M ₁	182.65	64.54	127.62	M ₂ T ₁	154.71	53.46	122.18
M ₂	163.07	54.81	122.88	M ₂ T ₂	171.43	56.15	123.57
SEm±	5.60	1.17	0.20	SEm±	7.92	1.66	0.28
CD at 5%	16.43	3.45	0.58	CD at 5%	NS	NS	NS
	Factor B (Potassium levels)			Factor B x Factor C			
K ₁	205.93	72.98	130.83	K ₁ T ₁	198.61	71.81	130.28
K ₂	145.30	49.66	120.94	K ₁ T ₂	213.25	74.16	131.37
K ₃	167.36	56.37	123.98	K ₂ T ₁	135.89	48.32	120.15
SEm±	6.86	1.44	0.24	K ₂ T ₂	154.71	51.00	121.72
CD at 5%	20.12	4.22	0.71	K ₃ T ₁	163.28	53.69	123.20
	Factor C (Time of application)			K ₃ T ₂	171.43	59.06	124.77
T ₁	165.93	57.94	124.00	SEm±	9.70	2.04	0.34
T ₂	179.80	61.41	125.95	CD at 5%	NS	NS	NS
SEm±	5.60	1.17	0.20	Factor A x Factor B x Factor C			
CD at 5%	NS	3.45	0.58	M ₁ K ₁ T ₁	213.25	73.82	131.44
	Factor A x Factor B			M ₁ K ₁ T ₂	217.43	76.50	132.61
M ₁ K ₁	215.34	75.16	132.03	M ₁ K ₂ T ₁	146.35	53.69	123.38
M ₁ K ₂	156.8	55.37	124.05	M ₁ K ₂ T ₂	167.25	57.04	124.72
M ₁ K ₃	175.82	63.08	126.78	M ₁ K ₃ T ₁	171.85	59.73	125.89
M ₂ K ₁	196.52	70.80	129.63	M ₁ K ₃ T ₂	179.79	66.44	127.68
M ₂ K ₂	133.80	43.96	117.82	M ₂ K ₁ T ₁	183.98	69.79	129.11
M ₂ K ₃	158.89	49.66	121.18	M ₂ K ₁ T ₂	209.07	71.81	130.14
SEm±	9.70	2.04	0.34	M ₂ K ₂ T ₁	125.44	42.95	116.93
CD at 5%	NS	NS	1.01	M ₂ K ₂ T ₂	142.16	44.96	118.72
	Factor A x Factor C			M ₂ K ₃ T ₁	154.71	47.65	120.51
M ₁ T ₁	177.15	62.41	126.90	M ₂ K ₃ T ₂	163.07	51.67	121.85
M ₁ T ₂	188.16	66.66	128.34	SEm±	13.72	2.88	0.49
	NS: Non-significant			CD at 5%	NS	NS	NS

condition (64.54 kg P₂O₅ ha⁻¹). Among the potassium levels, significantly higher available phosphorous was recorded with application of 25 kg K₂O ha⁻¹ (72.98 kg P₂O₅ ha⁻¹) compared to application of 37.5 kg K₂O ha⁻¹ (49.66 kg P₂O₅ ha⁻¹). Time of application also influenced the available phosphorous. The available phosphorous is significantly lower with basal application (57.94 kg P₂O₅ ha⁻¹) compared to split application of potassium fertilizer (61.41 kg P₂O₅ ha⁻¹). All the interaction effects are found to be non - significant for the available phosphorous after harvest. In the interaction of all the three factors available phosphorous in soil was highest with 25 kg ha⁻¹ of potassium application as split under drill sown condition (76.50 kg P₂O₅ ha⁻¹) and lowest available phosphorous in soil was recorded with 37.5 kg K₂O ha⁻¹ application as basal dose under transplanted condition (42.95 kg P₂O₅ ha⁻¹).

4.4.2.3 Available potassium

Available potassium influenced significantly due to methods of establishment. Available potassium after harvest of the crop was significantly lower in the transplanted condition (122.88 kg K₂O ha⁻¹) compared to the drill sown condition (127.62 kg K₂O ha⁻¹). Among the potassium levels, significantly higher available potassium was recorded with application of 25 kg K₂O ha⁻¹ (130.83 kg K₂O ha⁻¹) compared to application of 37.5 kg K₂O ha⁻¹ (120.94 kg K₂O ha⁻¹). Time of application also influenced the available phosphorous in soil after harvest of the crop. Significantly lower available potassium was recorded with basal application (124.00 kg K₂O ha⁻¹) compared to split application of potassium fertilizer (125.95 kg K₂O ha⁻¹). All the interaction effects are found to be non - significant for the available potassium after harvest. However, in the interaction of all the three factors available potassium in soil was highest with 25 kg ha⁻¹ of potassium application as split under drill sown condition (132.61 kg K₂O ha⁻¹) and lowest available potassium in soil was recorded with 37.5 kg K₂O ha⁻¹ application as basal dose under transplanted condition (116.93 kg K₂O ha⁻¹).

4.5 Economics of finger millet cultivation as influenced by method of establishment, different potassium levels and time of application

Data pertaining to the economics of maize cultivation as influenced by method of establishment, different potassium levels and time of application is depicted in Table 4.15.

Higher cost of cultivation (₹ 31,953 ha⁻¹) was observed with treatment received 50 kg K₂O ha⁻¹ as split dose under transplanted condition followed by 50 kg K₂O ha⁻¹ as split dose under drill sown condition (₹ 31,803 ha⁻¹).

Higher gross returns and net returns (₹ 10,7051 ha⁻¹ and ₹ 76,238 ha⁻¹, respectively) were recorded with treatment which received 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition and it was followed by application of 37.5 kg

Table 4.15: Economics of finger millet as influenced by method of establishment, different potassium levels and time of application

Treatment combinations	Cost of cultivation (₹ ha ⁻¹)	gross returns (₹ ha ⁻¹)	net returns (₹ ha ⁻¹)	B:C ratio
M ₁ K ₁ T ₁	30289	74625	44336	2.46
M ₁ K ₁ T ₂	31089	68681	37592	2.20
M ₁ K ₂ T ₁	30663	100858	70195	3.28
M ₁ K ₂ T ₂	31463	99473	68010	3.16
M ₁ K ₃ T ₁	31003	98758	67755	3.18
M ₁ K ₃ T ₂	31803	98236	66433	3.08
M ₂ K ₁ T ₁	30439	87821	57382	2.88
M ₂ K ₁ T ₂	31239	79613	48374	2.54
M ₂ K ₂ T ₁	30813	107051	76238	3.47
M ₂ K ₂ T ₂	31613	106703	75090	3.37
M ₂ K ₃ T ₁	31153	106152	74999	3.40
M ₂ K ₃ T ₂	31953	104512	72559	3.27

M₁: Drill sown

K₁: 25 kg ha⁻¹

T₁: 100 per cent Basal at sowing

M₂: Transplanting

K₂: 37.5 kg ha⁻¹

T₂: 50 per cent basal + 50 per cent top dressing

K₃: 50 kg ha⁻¹

of K fertilizer

K₂O ha⁻¹ as split dose under transplanted condition (₹ 10,6703 ha⁻¹ and ₹ 75,090 ha⁻¹, respectively).

Higher B: C of 3.47 was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition and it was on par with application of 50 kg K₂O ha⁻¹ as basal dose under transplanted condition (3.40). Whereas, it was 57.72 per cent higher over application of 25 kg K₂O ha⁻¹ as split dose under drill sown condition.

DISCUSSION

V DISCUSSION

Finger millet [*Eleusine coracana* (L.) Gaertn.] is an important food grain crop of semi-arid tropics particularly of India and East Africa. It is a nutri-cereal (nutritious grain) ranks third in importance among the millets in the country after sorghum and pearl millet. It requires minimum rainfall of around 350-400 mm for successful cultivation but can be grown successfully in the areas receiving rainfall up to 1000 mm. It can be grown on a wide range of soils from very poor to very fertile. However, well drained loam or clay loam soils are best for finger millet cultivation.

There is a growing evidence of increasing deficiency of potassium as a result of imbalanced use of nitrogen or nitrogen and phosphorous fertilizers. Unfortunately, application of potassium did not receive due attention, as most Indian soils were believed to be adequate in native supply. The neglect of potassium application in India is evident from the highly imbalanced fertilizer consumption ratio in respect of potassium. The crop removal of nutrients is well above additions resulting in continuous depletion of soil fertility. In the year 2020, the deficit of potassium in Indian agriculture is projected to be around 10 million tones /annum while, the estimates of Nitrogen and Phosphorous balances are positive. Development of practices to improve the efficiency of nutrients requires an understanding of the fate of the applied nutrient and their effect on crop production. Greater opportunities exist for increased crop production by increasing rate, timing and establishment methods. In case of finger millet also potassium nutrition is being neglected. Hence, there is a need to standardization the potassium management practices to enhance finger millet production especially under rain fed conditions. Under different agro- climatic condition demanding its detailed study in situations of direct seeded and as well as transplanted conditions.

Results of the field experiment entitled “**Effect of different potassium levels and time of application on growth and yield of finger millet under drill sown and transplanted conditions**” carried out at Agricultural and Horticultural Research Station (AHRs), Bavikere, Tarikere taluk, University of Agricultural and Horticultural Sciences, Navile, Shivamogga under rainfed conditions during *Kharif* 2016 presented in previous chapter are discussed here in the light of the studies conducted by earlier researchers under following headings

5.1 Influence of weather on performance of crop

5.2 Effect of methods of establishment on growth, yield, nutrient uptake and soil properties

5.3 Effect of different potassium levels on growth, yield, nutrient uptake and soil properties

5.4 Effect of time of application of potassium fertilizers on growth, yield, nutrient uptake and soil properties

5.5 Interaction effect of methods of establishment, different potassium levels and time of application on growth, yield, nutrient uptake and soil properties

5.6 Effect of methods of establishment, different potassium levels and time of application on economics of finger millet

5.1 Influence of weather on performance of crop

Environment is a basic and fundamental factor determining the growth of plants. Thus, fluctuation in weather conditions directly affects the crop growth and its developmental and expected yield. Thus the weather conditions prevailed during the period of experimentation would definitely have a direct bearing on potentiality of any crop in general and finger millet in particular.

The prevailing weather conditions during the crop growth period (August-November 2016) favoured the normal growth and development of finger millet (Table 3.2). The amount and distribution of rainfall varied during the cropping season. The rainfall received was maximum in the month of August (134.53 mm) which was deficits in rainfall as compared to normal rainfall of the station during particular month. The monthly maximum temperature was recorded highest in the month of November (27.81° C) and lowest in the month of August (26.39° C). Monthly minimum temperature was recorded highest in the month of August (22.06° C) and less during November. Relative humidity was maximum in the month of August (89.86 %) which was 20.60 per cent higher than normal. The sunshine hours are higher in the month of October and November (7.2 and 8.7 hrs). The overall weather conditions prevailed during cropping season in nearly normal. A total of 310.70 mm rainfall was received during the crop period. Thus the overall climatic conditions were congenial for successful crop growth. There was no significant incidence of pests and diseases during the crop growth period. Therefore, the crop produced normal yield in transplanted and drill sown condition.

5.2 Effect of methods of establishment on growth, yield, nutrient uptake and soil properties

The secret of boosting crops yields mainly lies with methods of establishment and use of further suitable nutrients. Method of sowing is an important agronomic factor affecting the productivity of crop. Proper sowing method is the important nonmonetary input in crop production, which affects the crop growth, yield and quality to greater extent. Method of establishment play important role to fully exploit all available resources for growth as it provides optimum growing condition.



Plate 5. 1: Different growth stages of finger millet

Yield is a complex trait resulting from the interaction of morphological, physiological and environmental parameters on the growth of plants. In the present investigation, transplanting method has achieved significantly higher grain yield (3,300 kg ha⁻¹) and straw yield (6,270 kg ha⁻¹) when compared to drill sown method (Table 4.9 and Fig 5.1). Significantly higher grain yield might be due to their reaction to the available soil moisture during early growth stages and tillering. The higher yield levels associated with establishment techniques can be traced back to higher values of yield attributing characters of an individual plant *viz.*, number of tillers, number of ear heads, number of fingers per ear head and test weight (Table 4.8 and Fig 5.2). Straw yield was more due to taller plants, more number of tillers and more dry matter production. Similar results have been reported by Upadhyay *et al.* (1998), Poorna Teja *et al.* (2014) and Sarawale *et al.* (2013).

The number of tillers in finger millet is influenced by establishment methods. At 30 days, drill sown crop recorded significantly higher number of tillers hill⁻¹ (2.04) than transplanted crop (1.09). This was due to transplanting shock experienced by the transplanted crop at early growth stages. At later stages, significantly the higher number of tillers was recorded with transplanted crop (4.77 hill⁻¹) as compared to drill sown crop (Table 4.6). 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⁻¹ (Nemoto and Yamazaki, 1995). The establishment of finger millet seedlings and their subsequent growth depends 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 similar results were also reported by Pradhan *et al.* (2011) in finger millet.

Harvest index (HI) is the best predictor of dry matter partitioning efficiency of the crop plant. In the present investigation, HI varied significantly across different establishment methods (Table 4.9). The pronounced improvement in HI (0.34) recorded with transplanting method might be attributed to the fact that more photosynthate was diverted to the reproductive part as evident from the significantly higher test weight and grain weight per plants. These results are in line with the results of Mohan Kumar *et al.* (2015).

Further increased grain and straw yield in transplanted crop is attributed to improved growth parameters like significantly higher dry matter production, taller plants, higher number of functional leaves, leaf area, leaf area index, leaf area duration (Table 4.1 to 4.7). The soil moisture condition was favorable at the time of transplanting due to the evenly distributed rainfall. Hence, transplanting resulted in

good establishment of the crop initially. As the pest and disease incidence was meager and even distribution of monsoon maintaining good soil moisture condition resulted in good final stands. The increased growth parameters associated with transplanting method may be attributed to the fact that each individual plant in transplanted crop got the advantages of more nutrients and other growth resources due to less weed competition at critical period. These results are in conformity with Sarawale *et al.* (2013).

Increase in dry matter production per unit area is a first step in achieving higher yield. Dry matter production during various growth stages of any crop is an important pre-requisite for higher yields as it signifies photosynthetic ability of the crop and also indicates other synthesis process during developmental sequence. After 30 days, significantly higher total dry matter production was recorded in transplanted crop (43.58 g plant⁻¹ at harvest) as compared to drill sown crop (Table 4.7). These results are in line with the findings of Padhi *et al.* (2010), Ravi (1984), Newase *et al.* (1995) Ehsanullah *et al.* (1998) and Ahiwale *et al.* (2011).

Dry matter production and its accumulation in various plant parts depend upon photosynthetic capacity of plants in turn depends on dry matter accumulation in leaves which further influenced by total leaf area and leaf area index. Leaf area is an important parameter that focuses on photosynthetic activity and source for photosynthate and these two are linearly related. In this regard, it is important that plant should possess more number of leaves and as well its leaf longevity for autotrophic status. It is well known fact that the persistence of the assimilatory area is a pre-requisite for prolonged photosynthetic activity, higher number of tillers and ultimately productivity. In the present study, transplanting method recorded significantly higher leaf area in transplanted crop (885.59 cm² plant⁻¹ at 90 days) compared to drill sown crop (Fig 5.2). Leaf area significantly increased from earlier stage and reached peak then decreased at harvest. Maintenance of leaf area till the end signifies bulk of photosynthate production and also translocation of the same to sink (grain) till grain gets into physiological maturity.

The leaf area variation accounted positive contribution for biomass and on the similar lines growth indices were also computed. One of the important growth indicators which have been used as a photosynthetic system measurement is leaf area index (LAI). Leaf area index is related to the biologic and economic yields and increase in LAI causes higher yield (Singh *et al.*, 2009b). As seen from Table 4.4 and 4.5, leaf area index (2.95) and leaf area duration (46.23) was significantly higher in transplanted crop compared to drill sown crop. Hence, maintenance of leaf area, LAD till the end signifies bulk of photosynthate production and also translocation of the same to sink. The LAI registered a curvilinear trend of increasing up to 90 days and declined marginally later because of senescence and leaf folding. Steady increase in

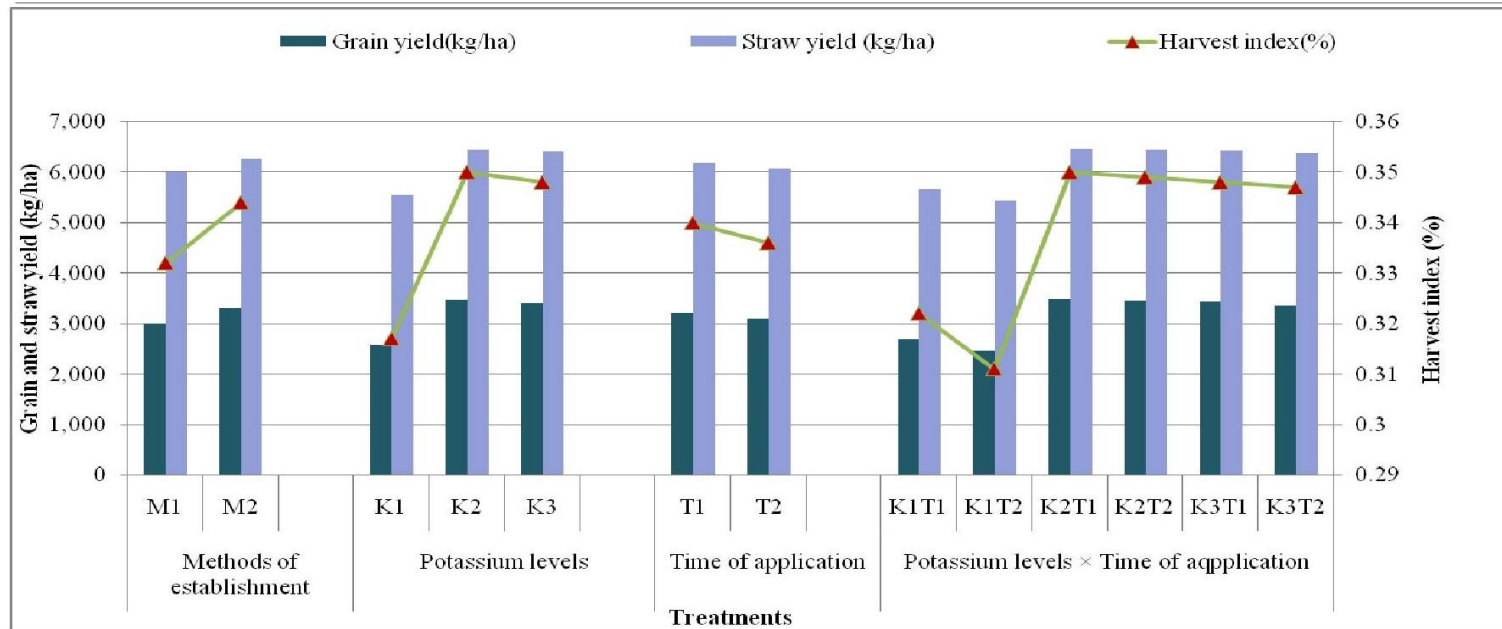


Fig. 5.1: Grain yield and straw yield of finger millet as influenced by method of establishment, different potassium levels and time of application

LEGEND:

Factor-A: Method of establishment

M₁: Drill sown

M₂: Transplanting

Factor-B: Potassium levels

K₁: 25 kg ha⁻¹

K₂: 37.5 kg ha⁻¹

K₃: 50 kg ha⁻¹

Factor-C: Time of application

T₁: 100 % Basal at sowing

T₂: 50 % Basal + 50 % top dressing of K fertilizer

these computed parameters *viz.*, leaf area index and leaf area duration eventually stands better in terms of crop performance. These results are in line with the results of Qazi Mehmood Ali (2013), Saad *et al.* (2014), Gangwar *et al.* (2012) and Dixit *et al.* (2010).

The higher leaf area achieved with transplanting method could be attributed to higher plant height which in turn resulted in more number of nodes per plant leading to more number of leaves per plant. The results on plant height differed significantly across the different growth stages by the different establishment methods at different stages. The plant height of finger millet found significantly higher in drill sown method than in transplanted at 30 days. However, at later stages significantly higher plant height recorded with transplanted crop (105.87 cm) as compared to drill sown crop (Table 4.1). Similar views were also expressed by Poorna Teja *et al.* (2014).

Improved yield and growth attributes might be interpreted as the manifestation of higher nutrient uptake by the plants. Significantly higher uptake of nitrogen, phosphorous and potassium were recorded with transplanted crop as compared to drill sown crop. Significantly higher uptake of total nitrogen (86.45 kg ha⁻¹), total phosphorous (31.34 kg ha⁻¹) and total potassium uptake at harvest (67.05 kg ha⁻¹) were recorded with transplanted method. Pronounced nutrient uptake with transplanted crop could be attributed to higher dry matter production. Spectacular increase in nitrogen, phosphorous and potassium uptake due to transplanting was earlier reported by Padhi *et al.* (2010).

Final nutrient status was found low (163.07 kg N ha⁻¹, 54.81 kg P₂O₅ ha⁻¹, 122.88 kg K₂O ha⁻¹) in transplanted condition as compared to drill sown crop. This might be due to higher grain and straw yields of crop, which results in extraction of the soil nutrients. Similar view was also expressed by Padhi *et al.* (2010).

Transplanting is an economically and environmentally ideal alternative to seeding. Transplanting achieves what many are looking to accomplish: increase yields and quality, while decreasing costs, inputs and environmental impact.

5.3 Effect of different potassium levels on growth, yield, nutrient uptake and soil properties

Potassium is the third most important macronutrient required for plant growth after nitrogen and phosphorous, and is one of the principle plant nutrients underpinning crop yield, production and quality determination. As potassium is involved in many physiological processes, its impact on water relations, photosynthesis, assimilate transport and enzyme activation can have direct consequences on crop productivity (Pettigrew, 2008) by regulating the opening and closing of stomata and therefore regulating moisture loss from the plant. For this reason, potassium is colloquially known as “poor-man’s irrigation” because it assists

crops to achieve yields more effectively (Soil Quality Organization, SQO, 2015). Additionally potassium also plays a significant role in photophosphorylation, turgor maintenance, photoassimilate transport from source tissues via phloem to sink tissues, stress tolerance and enzyme activation in plants (Usherwood, 2000). Potassium is considered to be a key osmoticum in plants as it provides water relations for plants making them to survive under drought situations. Potassium enhances water uptake of a plant to keep hold of cell turgor required for development and growth of a crop when it accumulates in growth of a plant (De La Guardia and Benlloch, 1980) and stomatal opening and potassium is considered to be mobile in plant and can be translocated against strong electrical and chemical gradients (Brar and Tiwari 2004). Potassium plays a remarkable role in transpiration, stomatal opening and closing and osmoregulation (Cakmak 2005, Millford and Johnson 2002).

In the present investigation, the grain yield of finger millet was significantly influenced by different potassium levels. Application of 37.5 kg K₂O ha⁻¹ recorded significantly higher grain yield (3,467 kg ha⁻¹) as compared to the application of 25 kg K₂O ha⁻¹ (2577 kg ha⁻¹). This was closely followed by the application of 50 kg K₂O ha⁻¹ (3411 kg ha⁻¹). The increase in the yield which received 37.5 kg K₂O ha⁻¹ was up to the tune of 34.53 per cent over the application of 25 kg K₂O ha⁻¹. This positive effect of potassium on yield components due to its requirement in protein synthesis and translocation of photosynthates from source to sink. Potassium is one of the principle plant nutrients determining yield and quality of the crop. While involved in many physiological processes, potassium impact on water relations, photosynthesis and enzyme activation can have a direct consequences on crop productivity (Oosterhuis *et al.*, 2014). Ralph and Forster (1976) made the observation that under optimum potassium nutritional conditions the senescence of the flag leaf is delayed. This results in a prolonged “leaf area duration” which according to Evans *et al.* (1975) is important for grain development. Potassium deficiency in entire treatment receiving 25 kg K₂O ha⁻¹ may lead to a reduction in photosynthetic assimilates available for growth. Further, reduced assimilate transport out of the leaves to the developing fruit due to potassium deficiency greatly contribute to the negative consequences on yield and quality production (Pettigrew, 2008). Similar results of higher yield with higher dose of potassium than the recommended dose in different cropping systems was reported by Ghosh *et al.* (2007), Ramachandrappa *et al.* (2014) and Robiul Alam *et al.* (2009) who stated that the grain yield progressively increased with the application of potassium and then decreased.

Harvest index (HI) is the best predictor of dry matter partitioning efficiency of the crop plant. In the present investigation, HI varied significantly across potassium

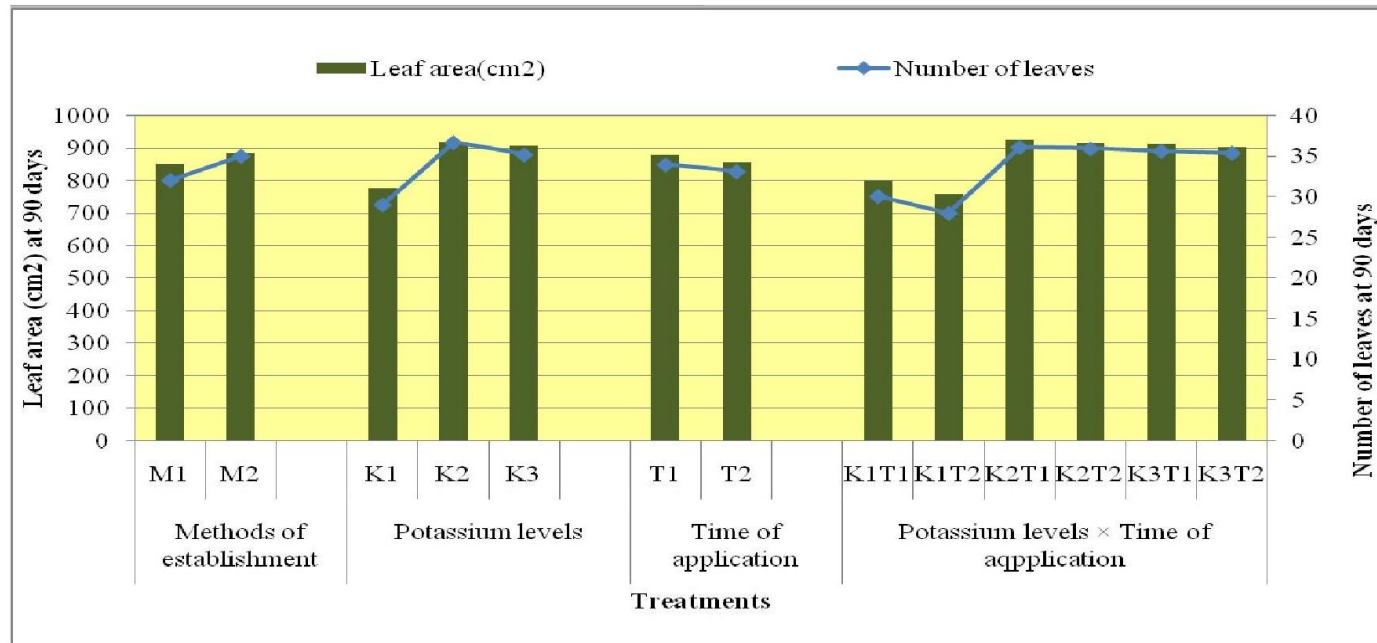


Fig. 5.2: Number of leaves and leaf area (cm²) of finger millet as influenced by method of establishment, different potassium levels and time of application

LEGEND:

Factor-A: Method of establishment

M₁: Drill sown

M₂: Transplanting

Factor-B: Potassium levels

K₁: 25 kg ha⁻¹

K₂: 37.5 kg ha⁻¹

K₃: 50 kg ha⁻¹

Factor-C: Time of application

T₁: 100 % Basal at sowing

T₂: 50 % Basal + 50 % top dressing of K fertilizer



Plate 5.2: Influence of methods of sowing, potassium levels and time of application on finger millet

levels (Table 4.9). The pronounced improvement in HI (0.35) recorded with increase as the level potassium application increased up to 150 percent RDK (37.5 kg K₂O ha⁻¹) might be attributed to the fact that more photosynthate was diverted to the reproductive part as evident from the significantly higher test weight (3.21 g) and grain weight per plants. These results are in accordance with the findings of Mohan kumar *et al.* (2015).

The increase in yield with application of 37.5 kg K₂O ha⁻¹ were traced back to higher values of yield attributes of an individual plant *viz.*, number of tillers (4.77), number of ear heads(4.43), number of fingers per ear head (9.04), test weight (3.21g) (Table 4.8). Hagra (1985) and Iftikhar Hussain (2002) also observed the similar response of increase in productive tillers or number of ear heads. This is due to adequate supply of nutrients through fertilizers which increased the metabolic activity in plants including growth and yield parameters. Crops responded positively to higher K levels when N is sufficient, and greater yield response to N fertilizer occurs when K is sufficient. A similar kind of results of increase in growth and yield parameters was reported by Abdullahi Baque *et al.* (2006).

The number of tillers was also influenced significantly by different levels of potassium. The treatment which received 37.5 kg K₂O ha⁻¹ has recorded significantly higher number of tillers (4.98 hill⁻¹) at harvest as compared to application of 25 kg K₂O ha⁻¹ (4.12 hill⁻¹). However, it was closely followed by application of 50 kg K₂O ha⁻¹ (4.89 hill⁻¹) (Table 4.6). This is due to adequate supply of nutrients through fertilizers which increased the metabolic activity in plants including growth and number of tillers. A similar kind of results was reported by Mahfuza *et al.* (2008) and Kacha *et al.* (2010).

The increase in grain and straw yield with application of 37.5 kg K₂O ha⁻¹ is attributed to higher total dry matter accumulation in leaves, stem and grain. The dry matter production increased as crop growth advances due to the application of higher dose than in RDK. There is no significant difference among the different potassium levels for total dry matter production at 30 days due to negligible influence on growth at early stages. The treatment which received 37.5 kg K₂O ha⁻¹ resulted in 33.12 per cent in dry matter production over 25 kg K₂O ha⁻¹ (Table 4.7). Higher dose of fertilizers in general and potassium in particular allowed for the efficient use of more nitrogen which results in production of long and wider leaves, profuse tillers and higher leaf area index ultimately resulting in vigorous growth and greater dry matter production. The present findings are in agreement with findings of Abdullahil *et al.* (2006).

In the present investigation, significant difference existed in plant height, number of leaves plant⁻¹, leaf area, leaf area index and leaf area duration of finger millet for different levels of potassium. Application of 37.5 kg K₂O ha⁻¹ recorded

significantly higher plant height (107.80 cm), number of leaves plant⁻¹ (26.02), leaf area (606.19 cm²), leaf area index (2.02) and leaf area duration (45.09) at harvest as compared to application of 25 kg K₂O ha⁻¹. However, it was closely followed by application of 50 kg K₂O ha⁻¹ (Table 4.1 to 4.5). The increase in the growth parameters might be due to an adequate supply and timely availability of nitrogen and potassium to the plants during their early growth period 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. These results are in conformity with the findings of Thippeswamy (1995) and Akbar Hossain *et al.* (2015).

Improved growth, yield attributes and yield of finger millet might be interpreted as the manifestation of higher nutrient uptake by the crop. Application of 37.5 kg K₂O ha⁻¹ has recorded significantly higher uptake of total nitrogen (89.84 kg ha⁻¹), total phosphorous (32.77 kg ha⁻¹) and total potassium (69.57) at harvest as compared to application of 25 kg K₂O ha⁻¹. However, it was on par with the application of 50 kg K₂O ha⁻¹. The increase in nutrient uptake was due to higher availability of nutrients leading to higher dry matter yield and nutrient concentration in plant with increased potassium application. Similar results were observed in finger millet by Shruthi *et al.* (2014).

Increased levels of potassium application showed significant variation in nutrient (K) uptake at all stages of crop growth. Application of 37.5 kg K₂O ha⁻¹ has recorded higher uptake of potassium by straw at all the growth stages (34.99, 42.49, 47.15 and 53.77 kg ha⁻¹ at 30 days, 60 days, 90 days and at harvest, respectively) as compared to application of 25 kg K₂O ha⁻¹. However, it was on par with the application of 50 kg K₂O ha⁻¹ (Table 4.12a and 4.12b). The nutrient uptake is a function of biomass and nutrient concentration in plant. Thus, significant improvement in uptake of potassium might be attributed to their increased concentration in plant. Use of higher dose of potassium might have helped for good vegetative growth and root system, which increased the higher K uptake by plants and hence increased yield and yield components of finger millet. The present findings are close association with the report of Thippeswamy and Shivakumar (2000) and Shruthi *et al.* (2014).

The data pertaining to final nutrient status of soil has been depicted in Table 4.14, available nitrogen, phosphorous and potassium status of soil after the crop harvest was significantly influenced by the application of different levels of potassium. Significantly higher available N, P₂O₅, K₂O was recorded in the treatment received 25 kg ha⁻¹ of potassium (205.93, 72.98, 130.83 kg ha⁻¹, respectively). While this treatment had taken up less N, P₂O₅, K₂O than others there by leaving behind

more in the soil. Significantly lower available N, P₂O₅, K₂O (145.30, 49.66, 120.94 kg ha⁻¹, respectively) was recorded with the application of 37.5 kg ha⁻¹ of potassium (Table 4.14 and Fig 5.12). This might be due to higher grain and straw yields of crop, which results in extraction of most of the soil nutrients. Similar views are expressed by Arulmozhiselvan *et al.* (2013). Soil pH, organic carbon and EC are non significant after harvest of the crop due to different potassium levels (Table 4.13).

5.4 Effect of time of application of potassium fertilizers on growth, yield, nutrient uptake and soil properties

Time of fertilizer application considerably influenced crop response to fertilizer. A number of factors like nature of the crop, its growth stages and nutrient requirements or crop needs, soil conditions, nature of fertilizer, etc., affect the time of fertilizer application. Nutrient application in splits ensured continuous and gradual supply of nutrients to the growing crop. Split application of nitrogen and potassium might have improved their absorption and assimilation. Application of Nitrogen and potassium at stages other than the critical period might have caused the crop to be under stress and deprived of sufficient nutrients at desired growth stages. This in turn might have decreased the enzyme activation and photosynthesis, as explained by Evans and Wildes (1971).

Light, temperature and mineral nutrients are the major environmental factors which determine the growth and dry matter productivity of crop plants. In agricultural practices the factor mineral nutrition is routinely manipulated to increase the yield. Adequate supply of essential nutrients in balanced way is one factor for getting good yield. Time of application of potassium is an important factor in increasing the efficiency of applied fertilizers in finger millet. Results of the present field trial showed that grain and straw yield differed significantly due to time of application of potassium fertilizers. Basal application of potassium fertilizer recorded significantly higher grain yield (3,203 kg ha⁻¹) and straw yield (6,179 kg ha⁻¹) than split application. Split application of potassium failed to bring about any significant difference in the grain and straw yields when compared to application of entire quantity of potassium at time of transplanting or drilling. The rate of accumulation of potassium during the first 30 days of growth exceeds that of both nitrogen and phosphorous, there by suggesting a greater requirement for potassium than nitrogen or even phosphorous as a starter element. In maize seedlings, absorption rate of nitrogen and phosphorous reached a maximum 28 days after germination, whilst the maximum rate of potassium absorption occurred immediately after germination (Minar and Lestuvka, 1969). Single grain weight depends much on the potassium status of the plant at the flowering stage. Late potassium application has little effect on the grain development (Mengel and Forster, 1971) and the rate of potassium uptake by cereals after flowering is probably very low. However, the potassium status of leaves and

culms at the grain filling period has a substantial impact on photosynthesis and on the translocation of photosynthates from these organs toward the earheads (Koch and Mengel, 1977). Similar findings were documented by Savitha *et al.* (2014) and Akbar Hossain *et al.* (2015).

Economic yield is a function of factors that contribute to yield which are known as yield attributes. The main yield attributes in finger millet are number of ear heads, number of fingers, test weight and grain yield. Basal application of potassium registered significantly higher yield components *viz.*, number of ear heads (4.21), number of fingers (8.77), test weight (3.11 g) and grain yield (3,203 kg ha⁻¹) as compared to split application of potassium (Table 4.8 and 4.9). Split application of potassium failed to bring about any significant difference in the yield parameters. Lack of response to split application of potassium, particularly at early stage for development requires higher potassium availability which is possible only when sufficient quantity is made available at the time of transplanting/ drilling and it was responsible for improvement in yield attributes. Similar view was also expressed by Ramachandrappa *et al.* (2014).

Total dry matter accumulation is the sum of dry matter accumulation in individual plant parts which depends on the moisture, nutrients and availability of light. Production and distribution of dry matter among the plant parts is very important in regulating the crop yield. The total dry matter production of finger millet not varied significantly at 30 days due to time of application. This was due to transplanting shock experienced by crop at growth stage. Basal application of potassium fertilizer recorded significantly higher total dry matter production (41.99 g plant⁻¹) at harvest compared to split application (40.28 g plant⁻¹) (Table.4.7 and Fig. 5.4). Potash behaves partly like nitrogen and partly like phosphorus. From the point of view of the rate of absorption, it is like nitrogen, being absorbed, up to the harvesting stage. But potash fertilizer like phosphate becomes available slowly. As such, it is always advisable to apply the entire quantity of potash at sowing time (Indrajit, 1998). These results are in conformity with the findings of Channabasappa *et al.* (1996).

In the present study, time of application significantly influenced the growth parameters of finger millet crop. A significant difference existed in plant height, number of leaves plant⁻¹, leaf area, leaf area index and leaf area duration of finger millet for different levels of potassium. Basal application of potassium has recorded significantly higher plant height (104.44 cm), number of leaves plant⁻¹ (24.32), leaf area (564.99 cm²) and leaf area index (1.88) at harvest compared to 50 per cent basal and 50per cent topdressing (Table 4.1 to 4.6). The improvement in plant growth parameters is attributed to increase nutrient uptake by plant parts. Being constituents of proteins, chlorophyll etc., they contribute for increased synthesis of carbohydrates

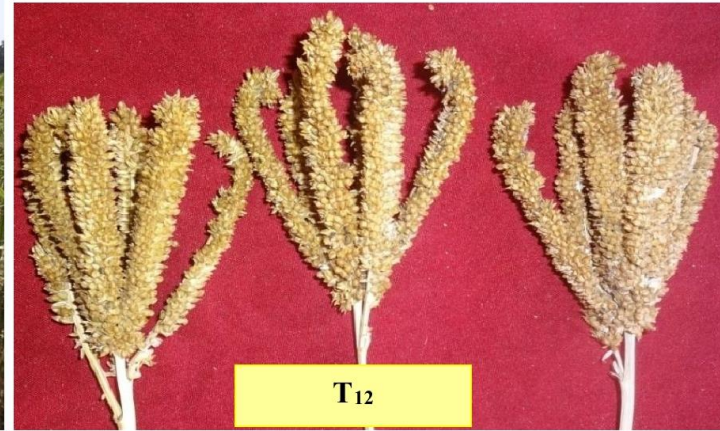


Plate 5.3: Crop stand of finger millet as influenced by time and potassium levels application under transplanted condition

which in turn utilized for building of new cells. The increased mineral nutrient availability has caused higher source activity coupled with larger leaf area, there was enhanced supply of photosynthates to growth and development of plant. Similar views were also expressed by Ramachandrappa *et al.* (2014) and Savitha *et al.* (2014).

The results of the present investigation revealed that, among the time of application basal application of potassium has recorded significantly higher total N, P₂O₅, K₂O uptake at harvest (83.44, 30.00, 65.26 kg ha⁻¹, respectively) compared to split application (81.23, 29.23, 63.79 kg ha⁻¹, respectively) (Table 4.10 to 4.12a and Fig 5.3). The higher uptake of nutrients from the soil is attributed to higher dry matter accumulation. When the crop growth was superior the yield levels will be superior as reported by Venugopal *et al.*, (2005), Shukla and Mishra (1998). Potassium uptake was rapid from 3 to 6 weeks after emergence. The uptake amount lower and more variable from the 8th week onwards this variability has been ascribed by Sayre (1955).

Available N, P and K status of soil after the crop harvest was significantly influenced by the time of application. Significantly higher available nitrogen, phosphorous and potassium (179.80, 61.41 and 125.95kg ha⁻¹, respectively) was noticed with split application of potassium compared to basal application. While this treatment had taken up less NPK than others there by leaving behind more in the soil (Table 4.14). This might be due to higher grain and straw yields of crop, which results in extraction of most of the soil nutrients. Similar views were also expressed by Ramachandrappa *et al.* (2014), Savitha *et al.* (2014) and Akbar Hossain *et al.* (2015).

5.5 Interaction effect of methods of establishment, different potassium levels and time of application on growth, yield, nutrient uptake and soil properties

In the present study, grain yield varied significantly due to interaction of methods of establishment × different potassium levels. The treatment which received 37.5 kg K₂O ha⁻¹ under transplanted condition recorded significantly higher grain yield (3,583 kg ha⁻¹) compared to all other treatment combinations. The per cent increase over the application of 25 kg K₂O ha⁻¹ under drill sown crop was 51.30 per cent. However, it was on par with 50 kg K₂O ha⁻¹ under transplanted condition (3,529 kg ha⁻¹). The higher grain yield of finger millet in these treatment combinations was mainly due to better translocation of photosynthates from source to sink which lead to better yield attributing characters like number of tillers, number of ear heads, number of fingers per ear head, test weight (Table 4.8 to 4.9). Similar view was also expressed Adikant Pradhan *et al.* (2015).

Among the interaction, potassium levels × time of application, basal application of 37.5 kg K₂O ha⁻¹ recorded significantly superior grain yield (3,482 kg ha⁻¹) compared to all other treatments. The per cent increase over the split application of 25 kg K₂O ha⁻¹ was 41.83 per cent. However, it was on par with the

split application of 37.5 kg K₂O ha⁻¹ (3,430 kg ha⁻¹). Finger millet responded more positively to basal application of 150 percent 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 was increased (Saleem *et al.*, 2010). The higher grain yield of finger millet in these treatment combinations was mainly attributed to higher yield parameters associated with the particular treatment. It has been widely demonstrated that potassium increases weight per grain (1000 grain weight). Potassium also increases apparent grain density by about 10% and in certain cases, by up to 25 per cent thus increasing flour yield when potassium is applied as basal dose (Quintanilla Rejado *et al.* 1978). These results are in conformity with the findings of Ahiwale *et al.* (2011) and Ramachandrappa *et al.* (2014).

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 ear heads, number of fingers per ear head, 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 ear heads, number of fingers per ear head and number of tillers. Basal application of 37.5 kg K₂O ha⁻¹ recorded significantly higher number of ear heads (4.44), number of fingers per ear head (9.06) and number of tillers (4.99) at harvest compared to all other treatment combinations. However, it was on par with the split application of 37.5 kg K₂O ha⁻¹. Due to the positive influence exerted by basal application of potassium on the number of tillers, number of ear heads, number of fingers per ear head, test weight of grains since it participates in the transportation of carbohydrates to the sink.

Interaction effect of methods of establishment × time of application also recorded significant effect for number of fingers per ear head and number of tillers. Application of 37.5 kg K₂O ha⁻¹ under transplanted condition recorded significantly higher number of fingers per ear head (9.19) and number of tillers (5.07) compared to all other treatment combinations. Higher basal dose of fertilizers in general and potassium in particularly allowed for the efficient use of more nitrogen which resulted in production of long and wider leaves, profuse tillers 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. Similar view was observed by Ravi and Rao (1992).

The yield components in turn depend on different growth functions *viz.*, dry matter, plant height, number of leaves, leaf area, LAI and LAD. Among the

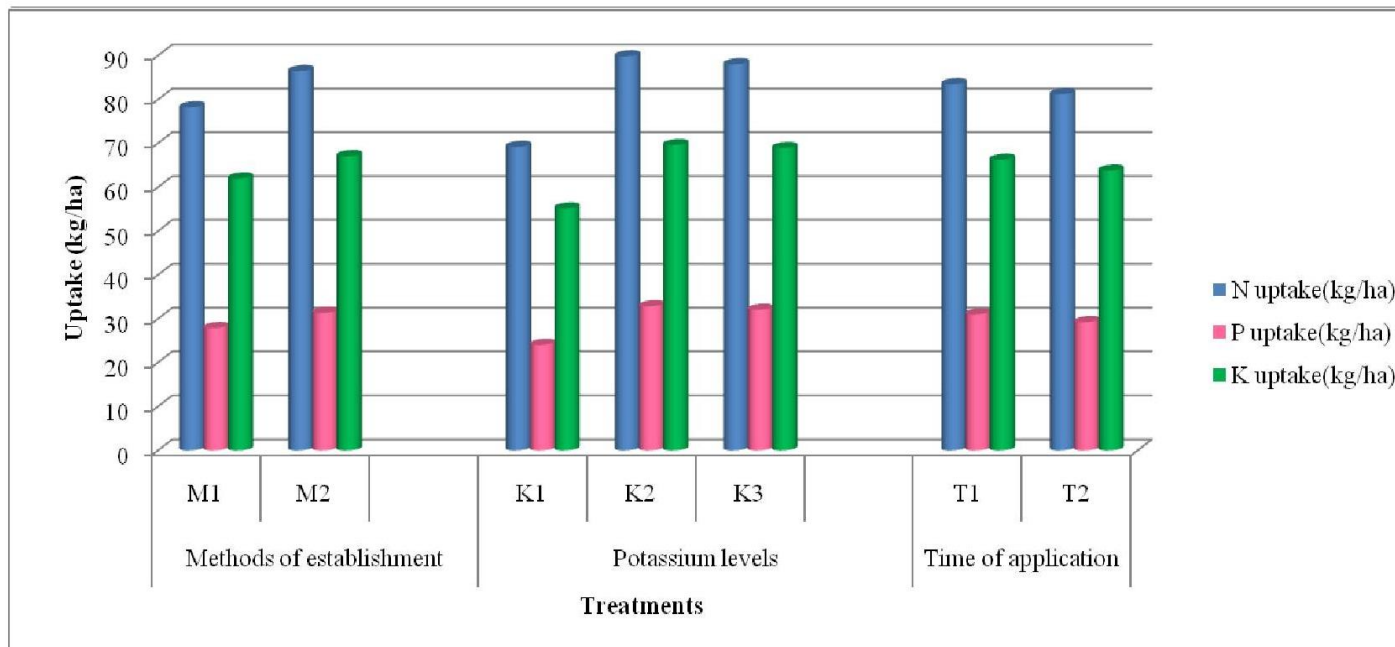


Fig. 5.3: Nitrogen, phosphorous and potassium uptake by total plant as influenced by method of establishment, different potassium levels and time of application

LEGEND:

Factor-A: Method of establishment

M₁: Drill sown

M₂: Transplanting

Factor-B: Potassium levels

K₁: 25 kg ha⁻¹

K₂: 37.5 kg ha⁻¹

K₃: 50 kg ha⁻¹

Factor-C: Time of application

T₁: 100 % Basal at sowing

T₂: 50 % Basal + 50 % top dressing of K fertilizer



Plate 5.4: Crop stand of finger millet as influenced by time and potassium levels application under drill sown condition

interactions, potassium levels \times time of application was found to be significant. Basal application of 37.5 kg K₂O ha⁻¹ recorded significantly higher dry matter (45.30 g plant⁻¹), plant height (107.93 cm), number of leaves (24.47), leaf area (608.53 cm² plant⁻¹), LAI (2.03) and LAD (23.35) at harvest compared to all other treatment combinations. All these might have promoted by more quantity of potassium nutrients along with recommended dose of nitrogen and phosphorous 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. However, it was on par with split application of 37.5 kg K₂O ha⁻¹. Interaction effect of methods of establishment \times time of application also recorded significant effect. Application of 37.5 kg K₂O ha⁻¹ under transplanted condition recorded significantly higher dry matter (46.99 g plant⁻¹) and plant height (109.12 cm) at harvest compared to all other treatment combinations. However, it was on par with the application of 50 kg K₂O ha⁻¹ in transplanted crop. The soil moisture condition was favorable 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 associated with sufficient quantity of nutrients and other growth resources made available to the crop. Similar views were also observed by Vidya *et al.* (2011) and Hagrais *et al.* (2012).

Improved growth, yield attributes and yield of finger millet might be interpreted as the manifestation of higher nutrient uptake by the crop. Among the interaction effect, potassium levels \times time of application was found to be significant for potassium uptake at different growth stages. Basal application of 37.5 kg K₂O ha⁻¹ recorded significantly higher potassium uptake by straw (42.59, 47.25 and 53.91 kg ha⁻¹ at 60 days, 90 days and at harvest, respectively) compared to all other treatments and it was on par with the split application of 37.5 kg K₂O ha⁻¹. Higher nutrient uptake is well reflected in terms of higher grain and straw yield. Obviously this could be due to supply of more nutrients from basal application of nutrients and also due to higher uptake of nutrients by the crop. These results are in conformity with the findings of Channabasappa *et al.* (1996).

Among the interactions of all three factors higher amount of total N, P₂O₅, K₂O uptake by the crop was recorded with basal application of 37.5 kg K₂O ha⁻¹ in transplanted crop (94.15, 34.39 and 71.95 kg ha⁻¹, respectively at harvest) and it was on par with split application of 37.5 kg K₂O ha⁻¹ under transplanted condition. However, lower amount of total N, P₂O₅, K₂O uptake by the crop was recorded with split application of 25 kg K₂O ha⁻¹ in drill sown crop (94.15, 34.39 and 71.95 kg ha⁻¹, respectively at harvest). The higher uptake of nutrients from the soil is attributed to

higher dry matter accumulation. When the crop growth was superior the yield levels will be superior as reported by Venugopal *et al.*, (2005). Differential nutrient uptake across treatments resulted in variation in available soil nutrient status at harvest of the crop.

The nutrient retained in the soil after harvest of the crop mainly depends up on both supply of nutrients through various sources and uptake by the crop. In general, higher the uptake of nutrients by crop lower will be the residual available nutrients in the soil. Further, higher the supply of nutrients higher is the residual soil nutrients. However, several factors influence the uptake as well as availability of nutrients. Among the treatment combinations of all three factors, higher available N, P₂O₅ and K₂O in the soil after harvest of the crop was noticed in the plots which received split application of 25 kg K₂O ha⁻¹ under drill sown condition (217.43, 76.50 and 132.61 kg ha⁻¹, respectively) compared to all other treatment combination. However, it was on par with basal application of 25 kg K₂O ha⁻¹ in drill sown condition. These findings are in concomitant with findings of Ramachandrapa *et al.* (2014) and Savitha *et al.* (2014).

5.6 Effect of methods of establishment, different potassium levels and time of application on economics of finger millet

Economics is the ultimate criteria for acceptance or rejection and wider adoption of any technology. The finger millet is no exception to this. Among the different indicators of economic efficiency in any production system, net return has greater impact on the practical utility and acceptance of the technology by the farmers. Assessment of treatments in terms of economic traits revealed that the gross return, net returns and benefit cost (B: C) ratio differed due to methods of establishment, different potassium levels and time of application.

Higher gross returns (₹ 10,7051 ha⁻¹) was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition compared to application of 25 kg K₂O ha⁻¹ as split under drill sown condition (₹ 68,681 ha⁻¹). However, it was followed by application of 37.5 kg K₂O ha⁻¹ as split doses under transplanted condition (₹ 10,6703 ha⁻¹). Similar view was also expressed by Ramachandrapa *et al.* (2014).

Maximum net returns (₹ 76,238 ha⁻¹) was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition, followed by application of 37.5 kg K₂O ha⁻¹ as split in transplanted crop (₹ 75,090 ha⁻¹). Lowest gross return (₹ 37,592 ha⁻¹) was recorded with application of 25 kg K₂O ha⁻¹ as split in drill sown crop (Table 4.15). Highest B: C (3.47) was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition compared to all other treatment combinations. However, it was followed by application of 50 kg K₂O ha⁻¹ as basal dose in transplanted crop (3.40). Lower B: C ratio (2.20) was recorded with

application of 25 kg K₂O ha⁻¹ as split under drill sown condition. The higher B: C ratio might be due to higher net returns. These results are in conformity with the findings of Ghosh *et al.* (2011).

5.6 Conclusion

Application of Recommended N and P along with 150 per cent RDK (37.5 kg K₂O ha⁻¹) as basal dose was found better in terms of yield, gross returns, net returns and B: C ratio (3.39) under transplanted condition.

5.7 Future line of work

- 1) Effectiveness of higher dose of potassium under rainfed and irrigated condition needs to be studied.
- 2) Response of finger millet to different levels and split application of potassium to be studied under irrigated conditions.
- 3) Release pattern of potassium at different stages of the crop growth need to be assessed.
- 4) Impact of micronutrients along with higher dose of potassium on finger millet yield need to be studied.
- 5) Effectiveness of higher doses of potassium along with higher dose of nitrogen needs to be studied.

SUMMARY

VI SUMMARY

The summary of the experiment entitled “Effect of different potassium levels and time of application on growth and yield of finger millet [*Eleusine coracana* (L.) Gaertn.] under drill sown and transplanted conditions” during *Kharif* 2016 at AHRS, Bhavikere, UAHS, Shivamogga, are presented in this chapter.

The experiment was laid out in a randomized block design with factorial concept having three factors. The factors comprising of two methods of establishment (drill and transplanted), three levels of potassium application (25, 37.5 and 50 kg/ha) and two different time of application of potassium (basal and split) and replicated three times. Observation on growth, yield and their attributing parameters were recorded at 30, 60, 90 days after sowing/transplanting and at harvest stage of the crop. The salient findings of present investigation are summarized below.

6.1 Effect of methods of establishment on growth, yield, nutrient uptake by finger millet and final nutrient status

- Higher growth parameters such as plant height, number of leaves plant⁻¹, leaf area and total dry matter accumulation were observed in transplanted crop over drill sown crop.
- Transplanting method recorded significantly higher number of tillers plant⁻¹ at all the growth stages. Maximum number of tillers plant⁻¹ was recorded in transplanting method (4.77) as compared to drill sown condition.
- The yield attributes *viz.*, number of ear heads hill⁻¹, number of fingers ear head⁻¹ and 1000-grain weight were also higher in transplanted crop as compared to drill sown crop.
- Finger millet establishment through transplanting method achieved significantly higher grain and straw yield (3,300 and 6,270 kg ha⁻¹ respectively) as compared to drill sown crop (3,000 and 5,989 kg ha⁻¹, respectively).
- Higher nutrient uptake by finger millet crop was recorded with transplanting method over drill sown condition.
- Final nutrient status found low in transplanted crop as compared to drill sown crop.

Effect of different potassium levels on growth, yield, nutrient uptake by finger millet and soil properties

- Application of 37.5 kg K₂O ha⁻¹ has recorded significantly higher growth parameters *viz.*, plant height, number of tillers hill⁻¹, leaf area, LAI and total dry matter accumulation plant⁻¹ at different stages of crop growth.

- The yield parameters *viz.*, number of ear heads hill⁻¹, number of fingers ear head⁻¹ and 1000-grain weight were also higher in the treatment receiving 37.5 kg K₂O ha⁻¹ followed by application of 37.5 kg K₂O ha⁻¹.
- The highest grain yield of 3,467 kg ha⁻¹ was obtained with application of 37.5 kg K₂O ha⁻¹. The yield reduction of finger millet was to an extent of 25.67 per cent with application of 25 kg K₂O ha⁻¹.
- Application of 37.5 kg K₂O ha⁻¹ resulted in significantly higher nutrient uptake by finger millet as compared to the application of 25 kg K₂O ha⁻¹. However, it was on par with the application of 50 kg K₂O ha⁻¹.
- Significantly higher available N, P₂O₅, K₂O was recorded in the treatment received 25 kg ha⁻¹ of potassium compared to rest of the treatments.

6.2 Effect of time of application of potassium on growth, yield, nutrient uptake by finger millet and soil properties

- Basal application of potassium has recorded higher values of growth parameters *viz.*, plant height, number of leaves plant⁻¹, leaf area and leaf area index compared to 50 per cent as basal and 50 per cent as top dressing at different stages crop growth.
- Higher yield components *viz.*, number of ear heads, number of fingers, test weight and grain yield recorded with basal application of potassium compared to split dose application of potassium.
- The highest grain yield (3,203kg ha⁻¹) and straw yield (6,179kg ha⁻¹) was obtained with basal application of potassium fertilizer compared to split dose application.
- Significantly higher uptake of nitrogen, phosphorous and potassium was recorded with basal application of potassium as compared to split dose application of potassium.
- Higher available N, P₂O₅, K₂O was recorded significantly with split application of potassium compared to basal application.

6.3 Interaction effect of methods of establishment, different potassium levels and time of application

- Basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition recorded significantly higher growth parameters *viz.*, plant height, number of leaves plant⁻¹, leaf area and leaf area index compared to all other treatment combinations.
- Application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition recorded significantly higher yield components *viz.*, number of ear heads, number of fingers, test weight and grain yield as compared to all other treatment combinations.

- The highest grain yield (3,589 kg ha⁻¹) and straw yield (6,559 kg ha⁻¹) was obtained with basal application of 37.5 kg K₂O ha⁻¹ in transplanted crop compared to all other treatment combinations.
- Significantly higher uptake of nitrogen, phosphorous and potassium (94.15, 34.39 and 71.95 kg ha⁻¹, respectively) was recorded with basal application of 37.5 kg K₂O ha⁻¹ under transplanted condition as compared to all other treatment combinations.
- Higher available N, P₂O₅, K₂O was recorded with split application of 25 kg K₂O ha⁻¹ under drill sown condition compared to all other treatment combinations.

6.4 Effect of methods of establishment, different potassium levels and time of application on economics of finger millet

- Higher gross returns (₹ 10,7051 ha⁻¹), net returns (₹ 76,238 ha⁻¹) were realized with the application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition, followed by application of 37.5 kg K₂O ha⁻¹ as split doses under transplanted condition. Higher B: C ratio (3.47) was recorded with application of 37.5 kg K₂O ha⁻¹ as basal dose under transplanted condition compared to all other treatment combinations, whereas it was 57.72 per cent higher over split application of 25 kg K₂O ha⁻¹ under drill sown condition.

REFERENCES

VII REFERENCES

- ABDULLAHIL BAQUE, ABDUL KARIM, ABDUL HAMID AND HIDAKA TETSUSHI., 2006, Effects of fertilizer potassium on growth, yield and nutrient uptake of wheat under water stress conditions. *South pacific studies.*, **27**(1): 1-12.
- ADIKANT PRADHAN, SAO, A., PATEL, D. P., NAG, S. K. AND MUKHERJEE, SW. C., 2015, Effect of establishment methods and nitrogen levels on finger millet (*Eleusine coracana* L. Gaertn.). *Ann. Agric. Res.*, **36**(1): 107-113.
- AHIWALE, P. H., CHAVAN, L. S. AND JAGTAP, D. N., 2011, Effect of establishment methods and nutrient management on yield attributes and yield of finger millet. *Adv. Res J. Crop. Improve.*, **2**(2): 247-250.
- AKBAR HOSSAIN, JAIME, A., TEIXEIRA DA SILVA AND BODRUZZAMAN, M., 2015, Rate and application methods of potassium in light soil for irrigated spring wheat. *Songklanakar J. Sci. Technol.*, **37**(6): 635-642.
- ANONYMOUS, 2006, Package of practices, University of Agricultural Sciences, Bangalore.
- ARULMOZHISELVAN, K., ELAYARAJAN, M. AND SATHYA, S., 2013, Effect of long term fertilization and manuring on soil fertility, yield and uptake by finger millet on inceptisol. *Madras Agric. J.*, 100 (4-6): 490-494.
- ASHOK SINGH, J., KUMAR, P., CHAUHAN, N. AND SINGH, G. R., 2009, Effect of levels of potassium and manganese on the uptake of N, P and K and yield of wheat. *J. Agric. Physics.*, **9**: 28-32.
- ASIF IQBAL, AMANULLAH AND MAZHAR IQBAL, 2015, Impact of potassium rates and their application on dry matter partitioning, biomass and harvest index of maize (*Zea mays*) with and without cattle dung application. *Emirates J. food Agric.*, **27**(5): 447-453.
- BELLAKKI, M. A., BADANUR, V. P. AND SHETTY, R. A., 1997, Influence of long term use of organic and inorganic sources of nutrients on crop yield and nutrient uptake by irrigated paddy. *Karnataka J. Agric. Sci.*, **10**(3): 659-663.
- BHANU PRASAD REDDY, S., 2014, Effect of nitrogen and potassium on yield and quality of pearl millet. *Ph.D. thesis*, ACHARYA N.G. RANGA AGRIC. UNIV., Andhra Pradesh. (India). p. 124.
- BLACKMAN, V. H., 1919, The compound interest law and plant growth. *Annals of Botany*, **33**: 353-360.

- BRAR, M. S. AND TIWARI, K. S., 2004, Boosting seed cotton yield in Punjab with potassium. *Better Crops*, **88**: 28-30. *Journal of Plant Nutrition and Soil Science.*, **168**: 521-530.
- BRAR, M. S., PREETI SHRAMA, AMANDEEP SINGH, SANDHU, S. S., 2012, Nitrogen use efficiency (NUE), growth , yield parameters and yield of maize (*Zea mays* L.) as affected by K application. *Intl. Potash. Inst.*, **30**: 3-6.
- CAKMAK, I., 2005, the role of potassium in alleviating detrimental effects of abiotic stresses in plants. *Journal of Plant Nutrition and Soil Science.*, **168**: 521-530.
- CHANNABASAPPA, S., DINESHKUMAR, M., MASTHANA REDDY, B. S. AND MANJUNATH HEBBAR, 1996, Effect of split application of phosphorous and potassium on growth and yield of rice. *Karnataka J. Agric. Sci.*, **11**(1): 1-3.
- DE LA GUARDIA, M. D. AND BENLLOCH, M., 1980, Effects of potassium and gibberellic acid on stem growth of whole sunflower plants. *Physiologia Plantarum.*, **49**:443-448.
- DIXIT, A., MANES, G. S., SINGH, A., SINGH, C., DHALIWAL, I. S. AND MAHAJAN, G., 2010, Evaluation of direct-seeded rice drill against Japanese manual transplanted for higher productivity in rice. *Indian J. Agri .Sci.*, **80**(10): 884-87.
- DONALD, C. M., 1962, In search of yield. *J. Australian Inst. Agric. Sci.*, **28**: 171-172.
- DOTANIYA, M. L. AND KUSHWAH, S. K., 2013, Nutrients uptake ability of various rainy season crops grown in a vertisol of central India. *Afr. J. Agric. Res.*, **8**(44): 5592-5598.
- DWIVEDI, B. S., RAWAT, A. K., DIXIT, B. K. AND THAKUR, R. K., 2016, Effect of inputs integration on yield, uptake and economics of Kodo Millet (*Paspalum scrobiculatum* L.). *Economic Affairs.*, **61**(3): 519-524.
- EHSANULLAH, IJAZ IQBAL, ASHFAQ AHMAD AND SHAKEEL AHMAD RANDHAWA, 1998, Effect of direct seeding and transplanting methods on the yield and quality of fine rice basmati-370. *Int. J. Agric. Bio.*, **2**(3): 251–252.
- EVANS, L. T., WARDLAW, I. F., AND FISCHER, R. A., 1975, In “Crop philosophy”, p. 101-149.
- EVANS, S. AND WILDES, R. A., 1971, Potassium and its role in the enzyme activation. In: *Potassium in Biochemistry and Physiology*. International Potash Institute, Switzerland, p. 13-29.

- GANGWAR, K. S., CHAUDHARY, V. P., GANGWAR, B. AND PANDAY, D. K., 2012, Effect of crop establishment and tillage practice in rice based cropping systems. *Indian J. Agri. Sci.*, **79**(5): 334-39.
- GHOSH, B. N., KHOLA, O. P. S. AND DADHWAL, K. S., 2007, Potassium and crop rotation impact under minimum tillage on carbon sequestration and water retention characteristics in soils of N-W Himalayas. *Indian. J. Soil. Cons.*, **35**(2): 134-138.
- GHULAM ABBAS, 2013, profit maximizing level of potassium fertilizer in wheat production under arid environment. *Pak. J. Bot.*, **45**(3): 961-965.
- GOMEZ, K. A. AND GOMEZ, A. A., 1984, Statistical Procedures for Agricultural Research. *2nd Ed. John Willey and Sons, New York (USA)*, p. 639.
- GURKIRPAL SINGH, HARMEET SINGH AND KOLAR, J. S., 2006, Response of finger millet to nitrogen, phosphorus, potassium and zinc application. *J. Res. PAU.* **38**(1-2):14-16.
- GURUMURTHY, K. T., PRAKASHA, H. C., MAVARKAR, N. S. AND SRIDHARA, C. J., 2007, Effect of different levels of K on dry matter yield and uptake efficiency of K by different FCV tobacco varieties grown in southern transition zone of Karnataka. *Indian J. Environ. Ecopla.*, **14**(3): 701-704.
- HAGRAS, A. M., 1985, Response of wheat to nitrogen, phosphorus and potassium fertilization. *Ann. Agric. Sci.*, **23**(2): 1023-1035.
- HAGRAS, A. M., BASSTAWISI, O. E., ZAYED, B. A. AND ABDEL HAMEID, M. M., 2012, Effect of different dates and rates of potassium fertilizer application on yield of same rice genotypes under saline soil condition. *J. Plant Production, Mansoura Univ.*, **3**(8): 2299 – 2309.
- HARIKRISHNA, B. L., DASOG, G. AND PATIL, P. L., 2005, Uptake of NPK, nitrogen use efficiency and available NPK in soil at different growth stages of maize (*Zea mays* L.), *Karnataka J. Agric. Sci.*, **18**(2):375-382.
- HOSHIKAWA, K. AND ISHI, R., 1974, Gas exchange characteristics of 'young' rice seedlings raised in box. In: *Proceedings of Crop Science Society of Japan*, **43**: 5–6.
- HUSSAIN, S., RAMZAN, M., RANA, M. A., MANN, R. A. AND AKHTER, M., 2013, Effect of various planting techniques on yield and yield components of rice. *J. Anim. Plant Sci.*, **23**(2): 672-674.

- IFTIKHAR HUSSAIN, M., SHAMSHAD H. SHAH, SAJJAD HUSSAIN AND KHALID IQBAL, 2002, Growth, Yield and Quality Response of Three Wheat Varieties to Different Levels of N, P and K. *Int. J. Agri. Biol.*, **4**(3): 362-364.
- INDERJIT, 1998, Managing soil fertility in organic farming systems. *Canadian Journal of Botany.*, **76**:1-5.
- JACKSON, M. L., 1973, Soil chemical analysis, (Ed.). Prentice-Hall of India Pvt. Ltd., New Delhi.
- JACKSON, M. L., 1967, Soil chemical analysis, (Ed.). Prentice Hall of India Pvt. Ltd., New Delhi, pp. 183-192.
- JAGATHJOTHI, N., RAMAMOORTHY, K. AND SATHYA PRIYA, R., 2010, Influence of enriched FYM with inorganic fertilizers on nutrient uptake, soil available nutrients and productivity of rain fed finger millet. *Madras Agric. J.*, **97**(10-12): 385-387.
- KACHA, B. D. J., KHAFI, H. R., ASHA MEHTA, C., SHEKH, M. A. AND JADHAV, R. P., 2010, Effect of potassium and zinc on growth and yield of pearl millet. *Crop Res.*, **41**(1): 31-34.
- KOCH, K., AND MENGEL, K., 1977, *Agron. J.*, **69**: 477-480.
- KOLAR, J. S. AND GREWAL, H. S., 1989, Response of rice to potassium. *Int. Rice Res. Newslett.*, 14: 33.
- LADHA, J. K., DAWE, D., PATHAK, H., PADRE, A. T., YADAV, R. L., SINGH, BIJAY, SINGH, YADVINDER, SINGH, Y., SINGH, P., KUNDU, A. L., SAKAL, R., RAM, N., REGMI, A. P., GAMI, S. K., BHANDARI, A. L., AMIN, R., YADAV, C. R., BHATTARAI, S., DAS, S., AGGARWAL, H. P., GUPTA, R. K. AND HOBBS P. R., 2003, How extensive are yield declines in long-term Rice-Wheat Experiments in Asia. *Field crops Res.*, **81**:159-181.
- LAL, K., SWARUP, A. AND SINGH, K.N., 2007, Potassium balance and release kinetics of non-exchangeable K in a typic natrustalf as influenced by long-term fertilizer use in Rice-wheat Cropping System. *Agrochemicals.*, **51**: 95-104.
- LASTUVKA, Z. AND MINAR. J., 1970, The relation between nutrient solution concentration and growth and ion absorption of peas (*Pisum sativum* L.). II. Accumulation, distribution and utilisation of nitrogen phosphorus and Potassium. *Plant and Soil.*, **32**: 412-423.

- MAHFUZA, S. N., ISLAM, M. N., SHMIRA AKTAR, AMIN, M. R. AND ISLAM, M. A., 2008, Influence of split application of potassium on yield and yield contributing characters of rice cultivars- br11 and nizersail. *The Agriculturists* **6**(1&2): 84-89.
- MANZOOR, Z., AWAN, T. H., AHMAD, M., AKHTER, M. AND FAIZ, F. A., 2008, Effect of split application of potash on yield and yield related traits of basmati rice. *J. Anim. Pl. Sci.*, **18**(4):120-125.
- MENGEL, K. AND FOSTER, H., 1971, *Plant soil.*, **35**:65-75.
- MILLFROD, G. F. AND JOHNSTON, A. E., 2002, Potassium and nitrogen interactions in crop production. Proc. No: 615, International Fertilizer Society, York, UK.
- MOHAMMAD AKBAR, 2010, Calcium, Magnesium and Potassium status of southern dry zone of Karnataka and the effect of varying cationic ratios on yield of finger millet. *Ph.D. thesis*, Univ. Agric. Sci., Bangalore, Karnataka (India). p. 19.
- MOHAN KUMAR, R. HIREMATH, S. M. AND NADAGOUDA, B. T., 2015, Effect of single cross hybrids, plant population and fertility levels on productivity and economics of maize (*Zea mays*). *Indian J. Agron.*, **60**(3):431-435.
- MUHAMMAD TAHIR, 2008, Growth and Yield response of two wheat varieties to different potassium levels. *Pak. j. life soc. sci.*, **6**(2): 92-95.
- NAVEEN, D. V., GOWDA, R. C., SRINIVASAMURTY, C. A. AND RAMAKRISHNA PARAMA, V. R., 2016, Changes in available nitrogen, grain yield and nutrient uptake under varied levels of nitrogen applied to different nitrogen fertility gradient strips in finger millet crop. *Adv. Appl. Res.*, **8**(1): 8 – 13.
- NEMOTO, K. AND YAMAZAKI, K., 1995, Morphological studies of the rice plants. In: Matsuo T, Hoshikama K, eds. Science of the rice plants. *Food and Agricultural Policy Research Center*, Tokyo, **1**: 625–627.
- NEWASE, V. B., THORAT, S. T. AND CHAVAN, S. A., 1995, Effect of methods of planting and fertilizer application on the yield of *kharif ragi*. *J. Indian Soc. Agric. Res.*, **13**(2): 151-152.
- NIGADE, R. D., AND MORE, S. M., 2014, Integrated nutrient management studies in finger millet. *Crop Res.*, **48**(2): 27-31.
- OOSTERHUIS, D. M., LOKA, D. A., KAWAKAMI, E. M. AND PETTIGREW, W. T., 2014, The physiology of potassium in crop production. *Advances in Agronomy.*, **126**: 203 -233.

- PADHI, A. K., JENA, B. K. AND PANIGRAHI, R. K., 2010, Performance of double cropping systems involving legume vegetables and finger millet under rain fed condition. *Indian J. Agric. Res.*, **44**(1): 14 – 19.
- PAL, S., GHOSH, S. K. AND MUKHOPADHYAY, A. K., 2000, Split application of potassium on rice (*Oryza sativa*) in coastal zone of West Bengal. *Indian J. Agron.*, **45**(3): 575-579.
- PALLAVI, JOSEPH, B., AARIFF KHAN, M. A. AND HEMALATHA, S., 2016, Effect of integrated nutrient management on nutrient uptake, soil available nutrients and productivity of rain fed finger millet. *Int. J. Sci. Envi. Tech.*, **5**(5): 2798 – 2813.
- PANAULLAH, G. M., TIMSINA, J., SALEQUE, M. A., ISHAQUE, M., PATHAN, A. B. M. B. U., CONNOR, D. J., SAHA, P. K., QUAYYUM, M. A., HUMPHREYS, E. AND MEISNER., C. A., 2006, Nutrient Uptake and Apparent Balances for Rice-Wheat Sequences III. *Potassium. J. plant nutrition.*, **29**: 173-187.
- PANDA, S. C., MOHANTY, K., SAHOO, H. K. AND SAHOO, B. C., 1999, Effect of continuous manuring in rice-rice cropping system. *Oryza.*, **36**(2): 139-142.
- PETTIGREW, W. T., 2008, Potassium influences on yield and quality production for maize, wheat, soybean and cotton. *Physiologia Plantarum.*, **133**: 670-681.
- PIPER, C. S., 1966, Soil and Plant Analysis, *Inter Sci. Pub., Inc.*, New York.
- POORNA TEJA, S., 2014, Nitrogen management in transplanted ragi (*Eleusine coracana* (L) Gaertn) .*Ph.D. thesis*, Acharya N. G. Ranga Agricultural University, Andhra Pradesh (India). p. 12.
- POWER, J. F., WILLIS, W. O., GUNES, D. L. AND PEICHMAN, G. A., 1967, Effect of soil temperature, phosphorus and plant age on growth analysis of barley. *Agron. J.*, **59**: 231-234.
- PRABHAVATHI, K., BIDAR, B. I., SHASHIDHARA, G. B. AND MATHAD, J. C., 2008, Influence of sources and levels of potassium on quality attributes and nutrient composition of red chillies. *Karnataka J. Agric. Sci.*, **21**(3): 379-381.
- PRASAD, P. R., 1993, Studies on potassium in red and lateritic soils of Northern Karnataka. Ph. D. thesis, University of Agricultural Sciences, Dharwad, 134p.
- QAZI MEHMOOD ALI, 2013, Evaluation of Planting Methods for Growth and Yield of paddy under Agro-Ecological Conditions of District Shikarpur. *Am-Euras. J. Agric. & Environ. Sci.*, **13**(11): 1503-1508.

- QUINTANILLA REJADO, P., 1978, Potassium requirements of cereals. In: "Potassium Research - Reviews and Trends". pp. 239-258. International Potash Institute, Basel, Switzerland.
- RAJU, R. A., REDDY, K. A. AND REDDY, M. N., 1999, Potassium fertilization in rice (*Oryzasativa*) on vertisols of Godavari flood plains. *Indian J. Agron.*, **44**(1):99-101.
- RALPH, R. L., 1976. Ph.D. Thesis, Faculty of biology A, Cambridge University.
- RAMACHANDRAPPA, B. K., SATHISH, A., DHANAPAL, G. N., BALAKRISHNA REDDY, P. C., SHANKAR, M. A. AND SRIKANTH BABU. P. N., 2014, Potassium nutrition on yield and economics of rain fed finger millet in Eastern Dry Zone of Karnataka. *Indian J. Soil Cons.*, **42**(2): 188-195.
- RASOOL, G., KHATTAK, J. K., AND BHATTI, A. B. 1987. Comparative effective of potassium sulphate vs. potassium chloride on the yield and the chemical composition of maize under D.I. Khan Conditions. *Pakistan J. Agric. Res.*, **8**: 29-31.
- RAVI, K. AND RAO, K. R., 1992, Studies on levels and times of application of potassium for *kharif* rice (*Oryza sativa* L.). *The Andhra Agric. J.*, **39**(1 and 2): 74-76.
- RAVI, N., 1984, Influence of planting time and method of establishment on the growth and yields of rainfed ragi. *Mysore J. Agri. Sci.*, **21**(4): 3.
- RAVICHANDRAN, M. AND SRIRAMACHANDRASEKHARAN, M. V., 2011, Optimizing timing of potassium application in productivity enhancement of crops. *Karnataka J. Agric. Sci.*, **24**(1): 75-80.
- REDDY, D. V. V., UDAYAKUMAR, M., PRASAD, T. G., SEETHRAM, A. AND Y. A. NANJAREDDY, Y. A., 2004, Influence of NPK on Relative Stability of Harvest Index in Finger Millet. *Karnataka J. Agric. Sci.*, **17**(4): 691-695.
- REGMI, A. P., LADHA, J. K., PASUQUIN, E., PATHAK, H., HOBBS, P R., SHRESTHA L. L., GHARTI, D. B. AND DUVEILLER, E, 2002., The role of potassium in sustaining yields in a long-term rice-wheat experiment in the Indo-Gangetic Plains of Nepal. *Bio. Ferti. Soils.*, **36**: 240-247.
- ROBIULALAM, M., AKKASALI, M., MOLLA, M. S. H., MOMINM. A. AND MANNAN, M. A., 2009, Evaluation of different levels of potassium on the yield and protein content of wheat in the high Ganges river floodplain soil. *Bangladesh. J. Agric. Res.*, **34**(1): 97-104.

- ROS, C., BELL, R. W. AND WHITE, P. F., 2003, Seedling vigour and the early growth of transplanted rice (*Oryza sativa*). *Plant and Soil*, **252**: 325–337.
- ROY, D. K., CHAKRABORTY, T., SOUNDA. G. AND MAITRA. S., 2001, Effect of fertility levels and plant population on yield and uptake of nitrogen, phosphorus and potassium in finger millet (*Eleusine coracana*) in lateritic soil of West Bengal. *Indian J. Agro.*, **46**(4): 707- 711.
- SAAD, H. ABOU-KHADRAH., 2014, Effect of planting methods and sowing dates on yield and yield attributes of rice varieties under D.U.S. experiment. *Sci. Agri.* **8**(3): 133-139.
- SALEEM, A., HABIB IQBAL JAVED, RASHID SALEEM AND MUHAMMAD ANSAR, 2010, Effect of split application of potash fertilizer on maize and sorghum in Pakistan. *Pakistan J. Agric. Res.*, **24**(1-4): 31-34.
- SANTHY, P., SELVI, D., DHAKSHINAMOORTHY, M. AND KARTHIKEYAN, P.K., 2003, Effect of continuous application of potassium on crop yields, K uptake and soil K status in a long-term fertilizer experiment. *J. Potassium. Res.*, **19**: 49-54.
- SARAWALE, P. P., RAJEMAHADIK, V. A., SHENDAGE, G. B. AND MANE. S. V., 2106 Effect of different dareties and establishment methods on growth and yield of finger millet [*Eleusine coracana* (L.) Gaertn.] under *Konkan* Condition. *J. Indian Soc. Coastal Agric. Res.*, **34**(2): 22-26.
- SAVITA, DHANAPAL, G. N., SATISH KUMAR VERMA, 2015, Influence of potassium on dry land finger millet productivity. *Envi. Eco.*, **33**(1): 6-9.
- SHARIF, M. AND HUSSAIN, S., 1993, Maize response of potassium fertilizer at Mardan. *Sarhad J. Agric.*, **9**: 257-261.
- SHARMA, B. D. AND MISHRA, B., 1986, Potassium reserve and its fractionation in alluvial soils of western Uttar Pradesh. *J. Pot. Res.*, **2**: 90-95.
- SHRUTHI, 2014, Management of phosphorus and potassium in finger millet under *alfisols* of Bangalore rural district in Karnataka. *Ph.D. thesis*, Univ. Agric. Sci., Bangalore, Karnataka (India). p. 16.
- SHULK, A. K. AND MISHRA, R. R., 1998, Persistence of fertilizers on microbial population and enzyme activity field soil. *Indian J. Agric. Sci.*, **68**(1):44-45.
- SINGH, G. R., DIXIT, R. S. AND DWIVEDI, A. P., 2006, Effect of nitrogen, phosphorus and potassium levels on growth, yield and quality of hybrid rice. *Agron. N. D. Univ. Tech. India.*, **43**(1): 64-66.

- SINGH, K. D., KARI, S. AND VARADE, S. B., 1976, Structural and moisture retentions characteristics of lateritic soil as influenced by organic amendment. *J. Indian Soc. Soil Sci.*, **27**(3): 321-324.
- SINGH, P., AGRAWAL, M. AND AGRAWAL, S. B., 2009b, Evaluation of physiological, growth and yield responses of a tropical oil crop (*Brassica campestris* L. var. Kranti) under ambient ozone pollution at varying NPK levels. *Environmental Pollution*, **157**: 871-880.
- SPARKS AND HAUNG, P. M., 1985, Physical chemistry of soil potassium. In potassium in agriculture (ed.) Munson, R. D. *American Soc. Agro. J.*, p. 201-276.
- SRINIVASA, 2013, Studies on effect of graded levels of potassium under irrigated maize in southern dry zone of Karnataka. *M. Sc (Agri.) thesis*, University of Agricultural Sciences, Bengaluru.
- SRINIVASARAO, SUMANTA KUNDU, RAMACHANDRAPPA , B. K AND SHARANBHOOPAL REDDY, 2014, Potassium release characteristics, potassium balance, and finger millet (*Eleusine coracana* G.) yield sustainability in a 27- year long experiment on an Alfisol in the semi-arid tropical India. *Plant Soil*, **374**: 315–330.
- SUBBIAH, B. V. AND ASIJA, G. L., 1956, A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.*, **25**: 259-260.
- THIPPESWAMY, H. M. AND SHIVAKUMAR, B. G., 2000, Effect of levels and time of potassium application on nitrogen and potassium uptake pattern in finger millet (*Eleusine coracana* G.). *Ann. Agric. Res.*, **21**(3): 441-442.
- THIPPESWAMY, H. M., 1995, Dynamics of potassium and crop response studies in selected soil series of Alfisols of Karnataka. *Ph.D. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore.
- ULLAH, M. J., FAZLUL KARIM, M. S., MIA, M. S., SHAMSUDDOHA, M. AND BEGUM, N. J., 2005, Effect of nitrogen row spacing on potassium uptake pattern of foxtail millet. *Karnataka J. Agric. Sci.*, **18**(4): 896-902.
- ULLAMAN, W. J., KIRCHMAN, D. L. AND WELCH, W. A., 1996, Laboratory evidence by microbially mediated silicate mineral dissolution in nature. *Chem, Geol.*, **132**: 11-17.
- UPADHYAY, P. N., 1994, Response of GR11 rice (*Oryza sativa* L.) to potash under varying levels of NP fertility. *Gujarat Agric. Univ. Res. J.*, **21**(1): 6-11.

- UPADHYAY, P. N., DIXIT, A. G., PATEL, J. R. AND CHAVDA, J. R., 1998, Response of summer pearl millet (*Pennisetum glaucum*) to time and method of planting, age of seedling and phosphorus grown on loamy sand soils of Gujarat. *Ind. J. Agro.*, **46**(1):126-130.
- USHER WOOD, N. R., 2000, The influence of potassium on cotton quality. Agri-Briefs, Agronomic News No.8. Spring 2000. Potash and Phosphate Institute. Norcross, GA, USA.
- VEERABHADRAPPA BELLUNDAGI, UMESH, K. B. AND RAVI, S. C., 2016, Growth dynamics and forecasting of finger millet (Ragi) production in Karnataka. *Economic Affairs.*, **61**(2): 195-201.
- VELAYUTHAM, A., VELAYUDHAM, K. AND BALASUBRAMANIAN, R., 1992, Effect of split application of potassium to low land rice on NPK uptake and yield. *Orissa J. Agric. Res.*, **5**(3-4): 162-165.
- VENUGOPAL, N. V., SHANKAR, M. A., GAJANANA, G.N AND GANAPATI., 2005, Low till farming strategies and integrated plant nutrition supply for rain fed semi arid tropics. *Annul progress report on dry land agriculture.*, p. 65-67.
- VIDYA, 2011, Hybrid rice response to levels and time of potassium application .*Ph.D. thesis*, ACHARYA N.G. RANGA AGRIC. UNIV., Andhra Pradesh. (India). p. 112
- WALKLEY, A. AND BLACK, C. A., 1934, Estimation of organic carbon by chromic acid titration method. *Soil Science.*, **37**: 29-38.
- WANI, J. A., MALIK, M. A., DAR, M. A., FARIDA AKHTER AND RAINA, S.K., 2014, Impact of method of application and potassium concentration on yield of wheat. *J. Envi. Biol.*, **35**:623-626.
- WATSON, D. J., 1952, The physiological basis of variation in yield. *Adv. Agron.*, **4**: 101-145.
- WELLS, M. L. AND WOOD, B. W., 2007, Relationships between leaflet nitrogen: Potassium ratio and yield of pecan *Hort. Technology.*, **17**: 473-479.
- YADAV, B. S. AND SWAMI, B. N., 1988, Effect of potassium on dry matter yield, composition and uptake of nutrient by maize and change in potassium on cropping. *J. Indian Soc. Soil Sci.*, **36**: 730-742.

APPENDICES

APPENDIX – I
List of abbreviations

SYMBOL	ABBREVIATIONS
B:C	Benefit cost ratio
DAT	Days after Transplanting
DAS	Days after sowing
CD (0.05)	Critical difference at 5 per cent level
cm	Centimeter
cm ²	Centimeter square
dS m ⁻¹	Deci Siemens per metre
EC	Electrical conductivity
<i>et al.</i>	Co- workers/ co- authors
Fig.	Figure
FYM	Farmyard manure
g	Gram
g m ⁻²	Gram per square metre
ha	Hectare
<i>i.e.</i>	that is
K	Potassium
NS	Non significant
kg	Kilogram
kg ha ⁻¹	Kilogram per hectare
LAI	Leaf area index
LAD	Leaf area duration
N	Nitrogen
P	Phosphorus
plant ⁻¹	per plant
pH	Negative logarithm of hydrogen ion concentration
RBCD	Randomized Complete Block Design
SE m	Standard error of mean
⁰ C	Degree Celsius
<i>Viz</i>	Namely
%	Per cent
AHRS	Agricultural and Horticultural Research Station
RDF	Recommended dose of fertilizer
₹	Rupees
@	At the rate of

APPENDIX – II

Price of inputs and outputs used for calculating cost of cultivation

Sl. No.	Particulars	Price (₹)
1	Seed material (ML-365) Drill 10 kg ha ⁻¹ Transplanting 5 kg ha ⁻¹	50 kg ⁻¹
2	Inorganic fertilizers a. Urea b. DAP c. Muriate of Potash	25 kg ⁻¹ 6 kg ⁻¹ 17 kg ⁻¹
3	Organic Manures Farm yard manure	1600 t ⁻¹
4	Labour wages a. Men labour b. Women labour	200 day ⁻¹ 200 day ⁻¹
5	Bullock pair	650 day ⁻¹
6	Tractor rent	450 hr ⁻¹
7	Output Straw yield Grain yield	100 per quintal 2800 per quintal

Reference for price: Krishimaratavahini