NUTRIENT UPTAKE AND YIELD ATTRIBUTES OF CONTAINER GROWN ELEPHANT FOOT YAM AS INFLUENCED BY GROWTH MEDIUM, NUTRIENT AND IRRIGATION SCHEDULE

ABSTRACT

An experiment was done in the Instructional Farm, College of Agriculture, Vellayani to study the effect of growth medium, nutrient schedule and irrigation schedule on nutrient uptake and yield attributes of container grown elephant foot yam by raising elephant foot yam var. Gajendra in plastic sacks of uniform size with 12 treatment combinations involving three growth media (M_1 - soil : sand : FYM (farmyard manure) 1:1:1, M_2 - soil : coir pith : FYM 1:1:1 and M_3 - soil : coir pith : FYM 0.75:1.25:1), two nutrient schedule (N_1 – N and K in three splits and N_2 – N and K in six splits) and two irrigation schedule (I_1 - irrigation once in three days and I_2 - irrigation once in six days) with four replications in completely randomized design. Based on the result of this study, higher root number, weight plant $^{-1}$, corm weight plant $^{-1}$ and bulking rate of corm were recorded in the growth medium M_2, application of N and K in six splits and irrigation once in three days . Bulking rate of corm was observed to be higher between 4 MAP and 5 MAP in all the treatments. Higher corm yield plant^{-1}, utilization index, total dry matter production plant^{-1} and highest uptake of N and P was noticed with the growth medium M_2, application of N and K in six splits and irrigation once in three days. Corm yield and total dry matter production plant $^{-1}$ were positively and significantly correlated with N, P and K uptake plant $^{-1}$.

Key words : Elephant foot yam, Growth medium, nutrient schedule, irrigation schedule, yield attributes

INTRODUCTION

"Elephant foot yam *(Amorphophallus paeoniifolius* (Dennst.) Nicolson) is an important tuberous vegetable with good keeping quality. In addition to its high nutritive value and good culinary properties, it has medicinal values also. It is traditionally used for the treatment of various diseases such as piles, abdominal disorders, tumours, enlargement of spleen, asthma and rheumatism” (Singh and Wadhwa, 2014). “In the present context of shrinking land area available for cultivation especially in urban areas, elephant foot yam can be raised in containers in the available space around houses or on house terraces for which an ideal growth medium is necessary. Usually soil, sand and FYM are taken in 1:1:1 ratio to prepare the growth medium. Due to the present problems of availability and high cost of sand, it can be substituted with coir pith which is abundantly available in Kerala as a byproduct of coir industry. Use of coir pith will reduce the weight of the container”. (Limisha et. Al., 2017) “Organic farming is the thumb rule for raising crops on house terrace in containers. Elephant foot yam is amenable for organic cultivation. In the present study, the recommended dose of nutrients for elephant foot yam is applied in the growth medium through organic sources like groundnut cake, bone meal and wood ash. For field cultivation, it is recommended to apply nutrients in splits at 1 ½ months after planting (MAP) and 2 ½ MAP for elephant foot yam” as per KAU (2011). But more number of split application may be required for the crop grown in containers.

Padmanabhan and Swadija (2015) advocated “ration irrigation but daily irrigation for vegetables grown in containers on house terraces. However, daily irrigation is not required for a tuber crop like elephant foot yam. Hence, it is necessary to standardize frequency of irrigation for the crop grown in containers. At present, technology for organic production of elephant foot yam in containers is lacking. Hence the present study was undertaken in the Instructional Farm, College of Agriculture, Vellayani to find out the suitable growth medium and nutrient & irrigation schedule for elephant foot yam grown in containers”.

MATERIALS AND METHOD

The experiment was conducted by raising elephant foot yam var. Gajendra in plastic sacks during April to November 2016 with 12 treatment combinations involving three growth media (M_1 - soil : sand : FYM 1:1:1, M_2 - soil : coir pith : FYM 1:1:1 and M_3 - soil : coir pith : FYM 0.75:1.25:1), two nutrient schedule (N_1 – N and K in three splits at bimonthly interval and N_2 – N and K in six splits at monthly interval starting from 1 month after planting) and two irrigation schedule (I_1 - irrigation once in three days and I_2 - irrigation once in six days) with four replications in factorial completely randomized design. Plastic cement sacks of uniform size (capacity of 50 kg) were used as containers.

"Different growth media used in the experiment were prepared with soil, sand, FYM and coir pith in different proportions by volume .The growth medium M_1 was prepared by mixing 9 kg soil, 3 kg sand and 3 kg FYM, M_2 with 9 kg soil, 3 kg coir pith and 3kg FYM and M_3 with 7 kg soil, 3.75 kg coir pith and 3 kg FYM. Lime @ 10g and neem cake @ 100g per sack were applied initially in all growth media. Initially, the moisture content of growth media was brought to field capacity. Corm pieces of 250 g, treated with *Trichoderma* – cow dung slurry and shade dried, were planted in each sack". (Limisha et. Al., 2017)

"The recommended dose of 100:50:150 kg NPK ha^{-1} for elephant foot yam (KAU, 2011) was applied to each sack through organic manures like groundnut cake, bone meal and wood ash. Uniform dose of bone meal was applied as a single basal dose in all sacs prior to planting of corm. The groundnut cake and wood ash were given in split doses as per the treatments. The groundnut cake was made into 10 per cent slurry with water, fermented for three days and mixed with wood ash and applied. The crop was mulched with dry leaves throughout the growth period. No irrigation was given during rainy days. When irrigation was needed, measured quantity of water, calculated based on evaporation data taken from the Agro Meteorological Observatory in the College, was applied at different intervals as per the treatments either once in three days or once in six days". (Limisha et. Al., 2017)

Yield attributes were recorded at monthly interval and also at harvest. Number of roots per plant, weight of roots $plant^{-1}$ and weight of corm $plant^{-1}$ were recorded monthly by uprooting (destructive sampling) plants from each treatment from the 4^{th} replication. Number of roots per plant (Total number of roots in the uprooted sample plants was counted and average was worked out.), weight of roots $plant^{-1}$ (Fresh weight of roots in the uprooted sample plants were recorded and average was worked out in g $plant^{-1}$) and weight of corm $plant^{-1}$ (Weight of corm in the uprooted sample plants was recorded, mean value was worked out and expressed in g $plant^{-1}$) were recorded monthly by uprooting (destructive sampling) plants from each treatment.

Observation on time of corm initiation was made visually from the uprooted sample plants. Bulking Rate of Corm, the rate of increase in tuber weight per unit time and is an important measure of tuber growth. This was calculated from the data on corm weight $plant^{-1}$ at monthly interval. It is expressed as g day^{-1} $plant^{-1}$ on dry weight basis (Kumar, 1986).

$$\text{Bulking rate (BR)} = \frac{w2 - w1}{t2 - t1}$$

where w_1 – dry weight of tuber at time t_1

w_2 – dry weight of tuber at time t_2

The crop was harvested seven months after planting. At the time of harvest, weight of corm from the observational plants were recorded and average was calculated in g plant^{-1}. Utilization Index is the ratio of the tuber yield to top yield on fresh weight basis. This was worked out from the corm weight and top (pseudostem /leaf) weight of the observational plants.

The sample plants uprooted prior to general harvest were used for computing dry matter production. Fresh weight of each plant part was recorded and samples taken for estimating dry weight. Samples were first shade dried and then dried in an oven at 70 ± 5^0 C to a constant dry weight. The dry weight of each plant part was recorded and total dry matter production (TDMP) at harvest was computed in kg ha^{-1}. Samples of plants collected at harvest and dried to compute TDMP were used for the analysis of nutrient contents. Samples were ground to pass through a 0.5 mm sieve and digested for nutrient analysis. Nitrogen content in each plant part was estimated by the modified microkjeldhal method (Jackson, 1973).

The uptake was calculated by multiplying the N content of each plant part with corresponding dry weight and summing up the values. The uptake values were expressed in g plant^{-1}. Phosphorus content in the plant sample was determined colorimetrically (Piper, 1967). The uptake was calculated by multiplying the P content of each plant part with corresponding dry weight and adding up the values and expressed in g plant^{-1}. Potassium content was determined by flame photometry (Jackson, 1973). The uptake was calculated by multiplying the K content of each plant part with corresponding dry weight and summing up the values. The uptake values were expressed in g plant^{-1}.

RESULT AND DISCUSSION

At monthly interval, sample plants were uprooted from twelve treatment combinations in the fourth replication to study the influence of treatments on the tuberisation pattern in elephant foot yam grown in containers. When sample plants were observed at 1 MAP, no corm initiation was noticed in any treatment. Sprouting had occurred in all the treatments. At 2 MAP, corm development was observed in all the treatments. Thus it could be inferred that corm initiation might have occurred between 1 MAP and 2 MAP irrespective of treatments. The sample plants were also observed for number and fresh weight of roots produced plant^{-1} and weight of corm plant^{-1} at monthly interval. Number and weight of roots produced plant^{-1} showed an increasing trend upto 5 MAP and started declining afterwards in all the treatments (Fig1 and 2). The root number showed more than threefold increase from 1 MAP to 2 MAP and more than two fold increase from 2 MAP to 3 MAP with corresponding effect on root weight also.

At all stages of observation, root number plant^{-1} was the highest in the growth medium M_2. At 1 MAP and 2 MAP, both M_2 and M_3 produced more roots than M_1 and from 3 MAP onwards, the root number was the lowest in M_3. The fresh weight of roots plant^{-1} was the highest at each stage in the growth medium M_2 followed by M_1. Initially, the weight of corm plant^{-1} was the highest in the growth medium M_1 followed by M_2. From 3 MAP onwards, corm weight plant^{-1} was the highest in M_2 followed by M_1 (Fig 3). The results clearly revealed that sprouting, root formation, corn initiation and corm development in elephant foot yam were not affected when coir pith was used as a component of the growth medium.

Nutrient schedule could produce marked variation in root number and weight as well as corm weight plant^{-1} only from 5 MAP onwards when application of N and K in six splits registered higher values of these parameters (Fig 1,2 and 3). Although there was not much variation in root number and weight and corm weight plant^{-1} due to irrigation schedule during initial stages, irrigation once in three days recorded higher values of these parameters from 4 MAP onwards (Fig. 1, 2 and 3). Steady availability of nutrients due to more split application coupled with irrigation might have favoured root growth and uptake of nutrients during later stages resulting in higher corm development.

The calculated values of BR of corm indicated an increasing trend upto 5 MAP beyond which it declined towards harvest irrespective of treatments. The peak values were observed between 4 MAP and 5 MAP. Mukhopadhayay and Sen (1986) and Nair *et al*. (1991) have also reported steady increase in BR upto 5 to 6 MAP and maximum BR during fifth or sixth MAP. In the present study, maximum BR was observed slightly earlier (4 to 5 MAP) which might be due to early maturing (7 months) character of the var.Gajendra. The highest BR of corm was recorded in the growth medium M_2 . Application of N and K in six splits than three splits as well as irrigation once in three days than six days recorded higher BR at all stages of observation (Fig 4).

Among the twelve treatment combinations, $m_2n_2i_1$ registered higher root number plant^{-1} from 3 MAP onwards, higher root weight from 4 MAP onwards, higher corm weight from 5 MAP onwards and higher BR from 4 to 5 MAP onwards (Fig.1,2,3and 4). The data clearly revealed the dominance of the treatment combination $m_2n_2i_1$ which could be a reflection of main effects.

At harvest, significantly higher root number and root weight plant^{-1} were noticed in the growth medium M_2 which was on a par with M_1 in the case of root number and was superior to M_1 with respect to root weight plant^{-1} (Table 1). The lowest root number and weight were recorded in M_3. Use of coir pith as a component of growth medium in a suitable proportion as in M_2 favoured the root growth and activity. Corm yield plant^{-1} was profoundly influenced by growth medium, nutrient schedule and irrigation schedule (Table 2). The highest yield plant^{-1} was obtained in the growth medium M_2 followed by M_1 . The highest uptake of nutrients like N and P was also observed in the growth medium M_2. These favourable attributes might have resulted in the highest corm yield plant^{-1} at harvest in M_2 . John *et al*. (2015) also obtained the best yield of container grown brinjal with cow dung + coir pith in 1:1 ratio.

Corm yield was higher in the treatment receiving N and K application in six splits than in three splits which indicated the need for more split application of N and K for container cultivation of FYM. More frequent irrigation (irrigation once in three days) during non-rainy periods produced higher corm yield than irrigation once in six days. Santosa (2004) also observed that irrigation at seven days' interval reduced corm yield from plastic bags.

At harvest, no marked variation in top yield plant^{-1} in different growth meida was noticed. Higher top yield was obtained by the application of N and K in six splits than three splits. Irrigation schedule did not produce variation in the top yield at harvest.

As depicted in Table 2, the highest UI of 4.01 was noticed in the growth medium M_2 followed by M_1 and M_3 in that order which reflected the effect of growth medium on corm yield. Utilization index did not vary markedly with nutrient schedule while frequent irrigation (once in three days) favoured higher utilization index. As in the case of corm yield plant^{-1}, the highest TDMP of 321.31 g plant^{-1} was obtained in the growth medium M_2 followed by M_1 (Table 2). Dry matter production was markedly influenced due to application of N and K in six splits as well as frequent irrigation (once in three days).

It can be seen from Table 3 that nutrient uptake was differently influenced by the treatments. The growth medium M_2 which registered the highest TDMP also recorded the highest uptake of N (6.98 g plant^{-1}) and P (0.78 g plant^{-1}). But no variation between growth medium was observed with respect to K uptake . Higher uptake of N and K recorded due to more split application (six splits) of N and K. This might be due to slow and steady availability of these nutrients, minimizing the nutrient loss. Application of N and K in three or six splits did not affect P uptake as expected. Nutrient uptake was favoured due to frequent irrigation (once in three days) which might be due to the fact that moisture is necessary for absorption of nutrients. Corm yield as well as TDMP plant^{-1} were significantly and positively correlated with N, P and K uptake plant^{-1} (Table 4)

CONCLUSION

Based on the monthly observations, higher root number and weight plant $^{-1}$, corm weight plant $^{-1}$ and bulking rate of corm were recorded in the growth medium M_2. Application of N and K in six splits and irrigation once in three days produced higher values of these parameters. Bulking rate of corm was observed to be higher between 4 MAP and 5 MAP in all the treatments. The data clearly revealed the dominance of the treatment combination $m_2n_2i_1$ which could be a reflection of main effects. Corm initiation had occurred between 1 MAP and 2 MAP irrespective of the treatments. Higher corm yield plant^{-1} , utilization index and total dry matter production plant^{-1} could be produced by the growth medium M_2 followed by M_1, application of N and K in six splits and irrigation once in three days . The highest uptake of N and P was noticed with the growth medium M_2, application of N and K in six splits and irrigation once in three days. Corm yield and total dry matter production plant $^{-1}$ were positively and significantly correlated with N, P and K uptake plant $^{-1}$.

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Table 1. Effect of growth medium, nutrient schedule and irrigation schedule on root number and root weight plant^{-1} at harvest

Treatments	Root number plant $^{-1}$	Root fresh weight (g plant^{-1})
Growth medium (M)		
M_1 - soil : sand : FYM 1:1:1	254.17	110.42
M_2 - soil : coir pith : FYM 1:1:1	282.50	120.00
M_3- soil : coir pith : FYM 0.75:1.25:1	216.83	83.75
SEm±	11.585	3.164
CD(0.05)	33.810	9.230
Nutrient schedule (N)		
N_1 - N&K in 3 splits	235.39	98.61
N_2 - N&K in 6 splits	266.94	110.83
SEm±	9.459	2.583
CD(0.05)	27.60	7.54
Irrigation schedule (I)		
I_1 - Irrigation once in 3 days	264.61	107.78
I_2 - Irrigation once in 6 days	237.72	101.67
SEm±	9.459	2.583
CD(0.05)	-	-

Table 2. Effect of growth medium, nutrient schedule and irrigation schedule on yield, utilization index and dry matter production

Treatments	Corm yield (g plant^{-1})	Top yield (g plant^{-1})	Utilization index	Total dry matter production (g plant^{-1})
Growth medium (M)				
M_1 - soil : sand : FYM 1:1:1	1629.17	474.17	3.45	301.08
M_2 - soil : coir pith : FYM 1:1:1	1760.42	440.83	4.01	321.31
M_3- soil : coir pith : FYM 0.75:1.25:1	1383.33	434.58	3.2	256.89
SEm±	34.882	13.362	0.085	6.353
CD(0.05)	101.810	-	0.247	18.69
Nutrient schedule (N)				
N_1 - N&K in 3 splits	1531.94	433.89	3.54	282.40
N_2 - N&K in 6 splits	1650.00	465.83	3.56	303.79
SEm±	28.481	10.910	0.069	5.180
CD(0.05)	83.130	31.840	-	15.260
Irrigation schedule (I)				
I_1 - Irrigation once in 3 days	1773.61	461.39	3.88	324.86
I_2 - Irrigation once in 6 days	1408.33	438.33	3.23	261.33
SEm±	28.481	10.910	0.069	5.188
CD(0.05)	83.130	-	0.202	15.260

Table 3. Effect of growth medium, nutrient schedule and irrigation schedule on nutrient uptake, g $plant^{-1}$

Treatments	N uptake	P uptake	K uptake
Growth medium (M)			
M_1 - soil : sand : FYM 1:1:1	6.56	0.64	8.82
M_2 - soil : coir pith : FYM 1:1:1	6.98	0.78	8.77
M_3- soil : coir pith : FYM 0.75:1.25:1	5.56	0.59	8.14
SEm±	0.179	0.046	0.408
CD(0.05)	0.522	0.133	-
Nutrient schedule (N)			
N_1 - N&K in 3 splits	6.06	0.72	7.94
N_2 - N&K in 6 splits	6.67	0.62	9.20
SEm±	0.146	0.037	0.333
CD(0.05)	0.426	-	0.97
Irrigation schedule (I)			
I_1 - Irrigation once in 3 days	7.14	0.78	9.87
I_2 - Irrigation once in 6 days	5.59	0.56	7.27
SEm±	0.146	0.037	0.333
CD(0.05)	0.426	0.109	0.97

Table 4. Correlation analysis of corm yield and TDMP versus nutrient uptake

Variables correlated	Correlation coefficients
Corm yield x N uptake	0.986**
Corm yield x P uptake	0.700*
Corm yield x K uptake	0.841**
TDMP x N uptake	0.985**
TDMP x P uptake	0.691*
TDMP x K uptake	0.844**

** Significant at 1% level

*Significant at 5 % level

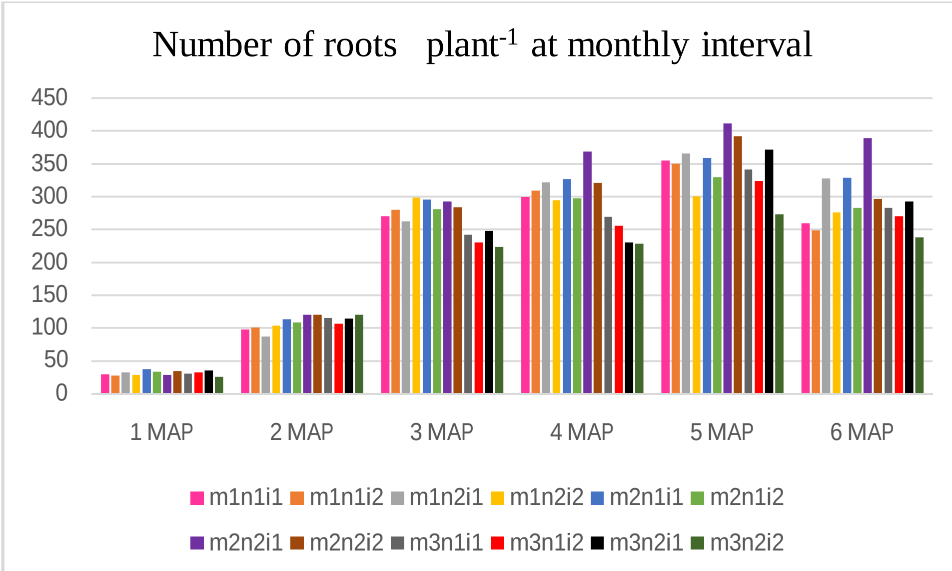

Fig 1. Number of roots plant^{-1} at monthly interval

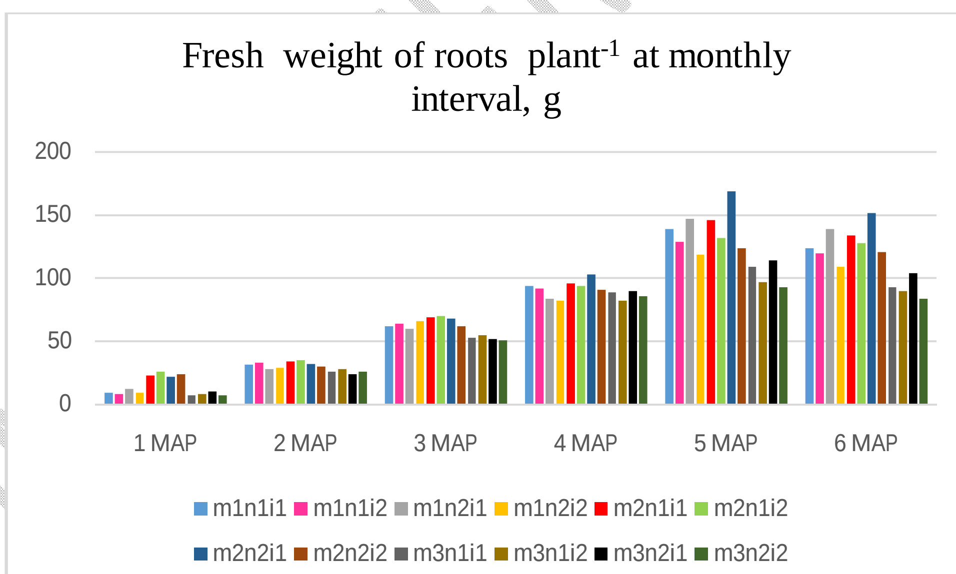

Fig 2. Fresh weight of roots plant^{-1} at monthly interval

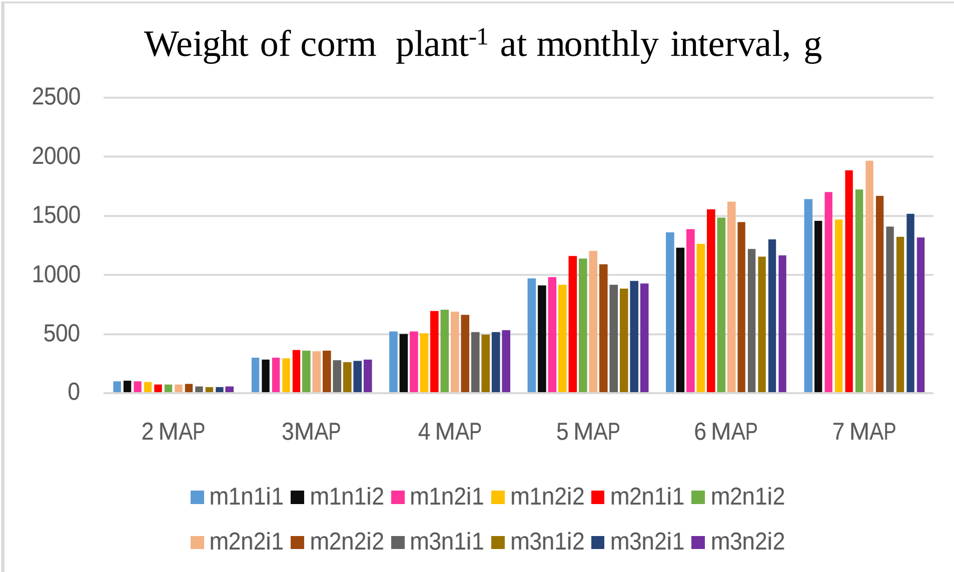

Fig 3. Weight of corm plant^{-1} at monthly interval

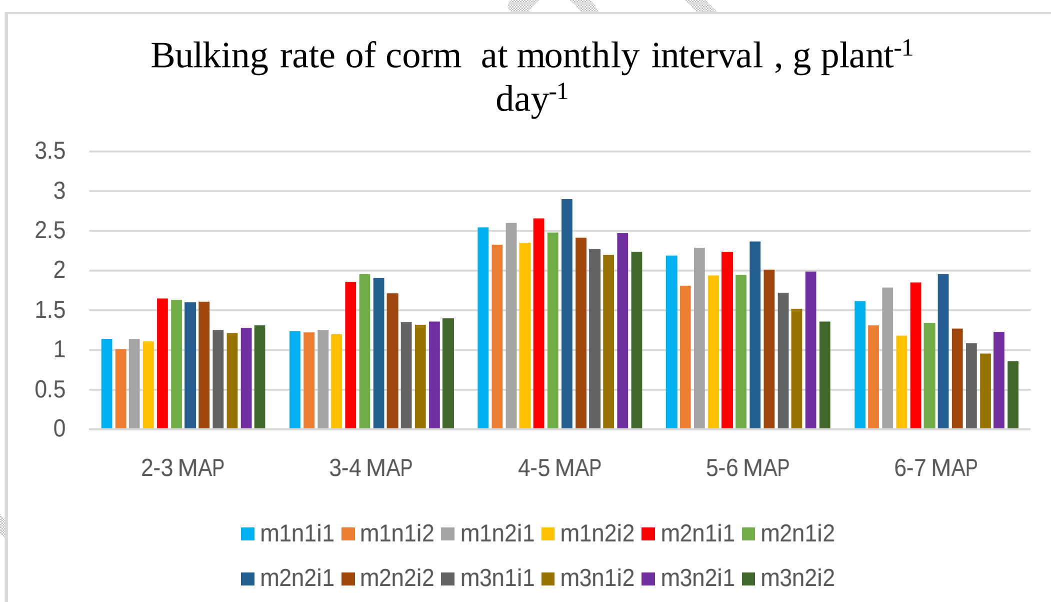

Fig 4. Bulking rate of corm at monthly interval