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INFLUENCE OF FISH BONE MEAL ON GROWTH AND YIELD OF TOMATO CROP

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ABSTRACT

A pot culture experiment was carried out to study the effect of using slow nutrient releasing fish bone meal on growth and yield of tomato crop during the *rabi* season. Application of the mineral fertilizer (DAP) with raw and acidulated fish bone meal (RFBM and AFBM) at different levels were imposed and the growth and yield parameters were recorded. The soil was slightly acidic in pH, low in nitrogen, high in phosphorus, medium in potassium and sufficient in all other nutrients. The growth parameters like plant height (60.97, 82.53 and 101.97 cm, respectively) and number of branches plant^{-1} (22.00, 28.33 and 30.67, respectively) at 30, 60 DAP and at harvest and yield parameters like fruit diameter, total number of fruits per plant, dry matter yield and total yield (6.68 cm, 42.00, 37.69 g plant^{-1} and 5.48 kg plant^{-1}, respectively at harvest) were recorded highest in treatment receiving 75 per cent recommended P through DAP and remaining 25 per cent through AFBM.

Key words : Acidulated fish bone meal, Fish bone meal, Phosphorus, Tomato, Yield.

Introduction

Now a days, there has been an increase in the demand for use of chemical fertilizers to get more yields from hybrids and improved varieties. Phosphorus is an essential input for successful crop production in agriculture. Being a vital element for plant growth and development, it plays a dominant role in plant structure, metabolism and energy transformation. Low Phosphorus Use Efficiency (PUE) (10 to 30%) of applied fertilizer due to high fixation characteristics in the acid soil and the recent steep hike in prices of phosphate fertilizers have further complicated the problems of their use by the farmers. Application of organic manures to soil such as bone meal, fish bone meal, farm yard manure, vermi-compost and biodynamic manures have been found to have beneficial effects on horticultural crops production.

Fish bone meal consists approximately 6 per cent N, 7 per cent P, 0.2 per cent K, 11 to 16 per cent of Ca. The phosphorus content of FBM varies from 6 to 9 per cent is majorly influenced by the bone content of raw material. FBM in the presence of biofertilizers and soil micro-flora in the soil is acted upon by certain organic acids. It releases phosphorus in the form of available mono calcium phosphate. Acidulation of phosphate rocks with acids helps to improve the nutrient availability by increasing water-soluble phosphorus. Treating phosphate rock with acid slowed down the immobilization of water-soluble P by reacting with some of the acidity produced during mono calcium phosphate hydrolysis, thus reducing the amount of acid available to solubilize soil Al and Fe. Acid reaction with phosphate rock could release additional P to the water-soluble pool (Mokwunye, 1980). So, the acidulation of FBM can improve the nutrient utilization of the crops. Therefore, the objective of the study was to assess the effect of fish bone meal on the growth and yield of tomato crop.

Materials and Methods

A pot experiment was conducted during *kharif* at the College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. The soil was slightly acidic in pH, low in nitrogen, medium in phosphorus, medium in potassium and sufficient in all other nutrients.

Treatment detail

The pot experiment was laid out with eleven treatments and three replications as shown in Table 1. Pots were filled with soil obtained at a depth of about 0 to 15cm. Individual pot capacity was of 10 kg soil. These pots were made ready for the crop production and further calculated quantity of fishbone meal, acidulated fish bone meal and FYM were applied to each pot seven days before planting of crop as per the treatments. Tomato hybrid, *i.e.*, SAKATA-914 was used for the experimentation. It is a determinate type of hybrid that grows to a height of 3 to 4 feet. The crop period is from 110 to 120 days yielding attractive red color tomato berries.

Table 1 : Treatment details of the experiment.

Treatment symbol	Treatment details
T_1	Control
T_2	250 kg P_2O_5 as DAP (Package of Practice)
T_3	187.5 kg P_2O_5 as DAP + 62.5 kg P_2O_5 as RFBM
T_4	125 kg P_2O_5 as DAP + 125 kg P_2O_5 as RFBM
T_5	187.5 kg P_2O_5 as DAP + 62.5 kg P_2O_5 as AFBM
T_6	125 kg P_2O_5 as DAP + 125 kg P_2O_5 as AFBM
T_7	200 kg P_2O_5 as DAP (80% recommended P_2O_5)
T_8	150 kg P_2O_5 as DAP + 50 kg P_2O_5 as RFBM
T_9	100 kg P_2O_5 as DAP + 100 kg P_2O_5 as RFBM
T_{10}	150 kg P_2O_5 as DAP + 50 kg P_2O_5 as AFBM
T_{11}	100 kg P_2O_5 as DAP + 100 kg P_2O_5 as AFBM

Note: DAP- diammonium phosphate, RFBM & AFBM- raw & acidulated fish bone meal.

The required recommended dose of nutrients for tomato used was 250 kg N, 250 kg P_2O_5 and 250 kg K_2O kg ha^{-1}. Nitrogen and phosphorus were applied through urea and DAP, while potash was applied using muriate of potash (MOP) as per calculation. Split application of nitrogen fertilizer was given half as basal dose and other half after four weeks of planting of crop. All the fertilizers were applied as basal and mixed with soil after planting the seedlings. The contribution of N and P from the fish bone meal and acidulated fish bone meal was taken into consideration during the application of fertilizers. The Phosphorus solubilising and mobilizing fungi such as *Aspergillus awamori* and *Glomus fasciculatum* (VAM) were applied to all the treatments.

Observations recorded

The following observations were recorded on the growth and yield parameters which are given as follows:

Growth attributes

Plant height : The height of the plant from the bottom (cotyledonary node) to the tip of the plant was measured at 30, 60 DAP (days after planting) and after final harvest, expressed in centimeter (cm).

Number of branches $plant^{-1}$: The number of branches borne on the main stem were counted at 30, 60 DAP and final harvest, expressed as number.

Yield and yield attributes

Fruit diameter/width : The diameter/width of the fruit was recorded by selecting harvested fruits from each plant and measured at the highest bulged portion by using vernier calipers and average width of the fruit was computed and expressed in centimeter (cm).

Total number of fruits $plant^{-1}$: The fruits harvested in all the pickings from individual plant were added and the average was worked out and expressed in number.

Total yield $plant^{-1}$: The fruits harvested at different pickings from individual plant were weighed and pooled and the average yield per plant was worked out and expressed in kg $plant^{-1}$.

Dry matter yield : Reliable estimates of vegetative dry matter yield by laboratory methods were reviewed by Pitt (1993). At harvest stage the entire plant was removed and places in oven dryer at 60-70 ^oC till constant weight was obtained. The percentage of dry matter was calculated based on moisture difference after drying the samples and expressed as kg $plant^{-1}$.

Results and Discussion

Effect on growth parameters

Data pertaining to plant height and number of branches at different days after transplanting is presented under Table 2. A keen observation of the data reveals that application of FBM with mineral P fertilizers treatment significantly increased the plant height (60.97, 82.53 and 101.97 cm, respectively) and number of branches (22.00, 28.33 and 30.67, respectively) at 30 and 60 DAP and after the final harvest of the tomato crop, found highest in the treatment receiving 75 per cent P through mineral fertilizer and remaining 25 per cent through AFBM. The increase in plant height might be due to continuous phosphorus availability from raw FBM and acidulated

Table 2 : Influence of FBM on plant height and number of branches at different growth stages of tomato.

Treatments	Plant height (cm)			No. of branches		
	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest
T_1	53.90	69.90	83.20	13.00	19.33	19.67
T_2	60.27	81.10	100.07	21.00	26.33	28.33
T_3	58.00	77.50	95.83	19.33	24.33	26.33
T_4	58.47	79.07	97.43	20.67	25.67	27.67
T_5	60.97	82.53	101.97	22.00	28.33	30.67
T_6	60.40	81.83	101.20	21.33	26.67	29.00
T_7	56.63	75.53	91.80	16.33	22.67	23.33
T_8	54.33	70.70	90.53	14.67	21.00	22.00
T_9	55.83	71.10	91.93	16.33	21.67	23.67
T_{10}	57.13	76.73	95.37	18.33	23.33	25.00
T_{11}	56.80	75.90	93.10	17.00	23.00	24.33
S. Em ±	**1.57**	**1.59**	**1.25**	**0.78**	**1.26**	**1.18**
CD @ (0.05)	**NS**	**4.66**	**3.68**	**2.30**	**3.68**	**3.45**

Table 3 : Influence of FBM on yield parameters and yield of tomato.

Treatments	Fruit diameter (cm)	Total no. of fruits plant^{-1}	Dry matter yield (g plant^{-1})	Total yield (kg plant^{-1})
T_1	5.45	20.33	23.99	1.52
T_2	6.10	34.67	32.24	4.86
T_3	6.01	31.33	27.96	4.05
T_4	6.12	33.67	30.47	4.50
T_5	6.68	42.00	37.69	5.48
T_6	6.23	36.33	35.30	5.25
T_7	5.89	27.33	26.73	3.26
T_8	5.67	22.67	25.15	2.61
T_9	5.83	26.33	25.73	2.96
T_{10}	5.94	30.67	27.03	3.87
T_{11}	5.93	27.67	26.69	3.71
S. Em ±	**0.20**	**1.02**	**0.68**	**0.09**
CD @ (0.05)	**0.60**	**2.99**	**1.99**	**0.26**

RFBM – Raw fish bone meal, AFBM – Acidulated fish bone meal, DAP – Days after planting, NS: Non –significant.

FBM application with DAP fertilizer as it plays an essential role in growth, development and photosynthesis, which might have reflected in higher values for plant height as reported by Salve *et al.* (2010) and Singh *et al.* (2018). The increase in tomato plant height was due to the increased availability of N, P, Ca and their beneficial effects on cell division and multiplication (Madhavi *et al*., 1997). Mineralization of organic P and solubilization of precipitated P by the micro-organisms also enhanced the P availability in soils, as observed by Chen *et al.* (2006). The increased biological nitrogen fixation may be the cause of the higher vegetative growth. Improved root system growth and potential may be attributed to the production of plant growth hormones such IAA, GA and cytokinins. Plant growth characteristics may have increased directly as a result of biofertilizers. Moreover, the improvement in growth traits might result from PSF's stimulative effect on P solubilization, which would enhance P availability and plant absorption. These results are in conformity with the findings of Poonia and Dhaka (2012). The high and continuous availability of phosphorus and its role in growth, development and photosynthesis might have reflected in more numbers of branches per plant. These results are in line with the findings of Pal *et al.* (2010), Patil *et al.* (2000) and Kundu *et al.* (2010).

Effect on yield and yield parameters of tomato

Data pertaining to the yield attributes, *viz.*, fruit diameter, total number of fruits per plant, total yield per plant and dry matter yield were significantly influenced due to the application of fish bone meal, the treatment receiving 75 per cent P through mineral fertilizer and remaining 25 per cent through AFBM recorded significantly higher fruit (5.48 kg plant^{-1}) yield, fruit diameter (6.68 cm), total number of fruits per plant (42.00) and dry matter yield 37.69 (g plant^{-1}) than the other treatments (Table 3 and Fig. 1). The increase may be imputed to increased P availability in soil due to the application of fish bone meal, which influenced the physiological processes directly related to nitrogen fixation, photosynthesis and translocation of carbohydrates for fruit development. The increase in diameter of the fruit may be due to the involvement of nitrogen content of AFBM and RFBM in chlorophyll formation. Apart from nitrogen calcium might have also helped to favor cell division, meristematic activity in apical tissue, expansion of cell and formation of a new cell wall, which in turn enhances the width of the fruit. The number of fruits per plant depends on the number of flowers and the ability of the plant to provide nutrients required for growth and development, which leads to the production of fruits in the plant. These findings follow previous studies of Paithankar *et al.* (2004) and Suganiya *et al.* (2015) in tomato. The greater availability of nutrients under the influence of FBM resulted in better growth and development of the plants. Ultimately, increase in the total yield per plant in tomato as also

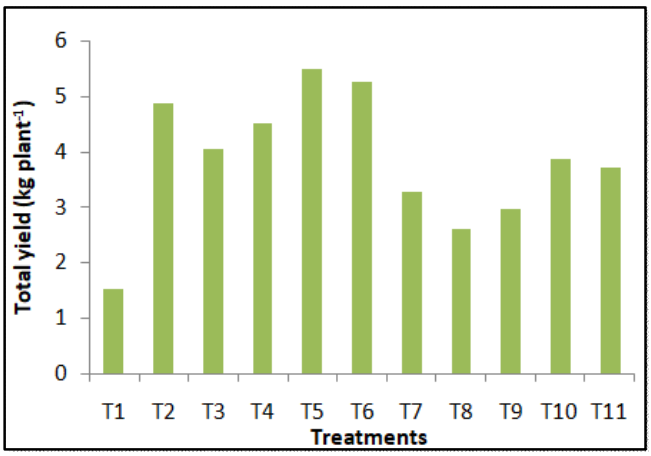

Fig. 1 : Influence of FBM on yield of tomato.

reported by Salomonsson *et al.* (1995) and Jeng *et al.* (2004). The fruit yield of tomato was significantly influenced due to fish bone meal and mineral fertilizer application. This may be ascribed to increased P availability in soil due to applied P content as mineral fertilizer in the initial growing period and through raw and acidulated FBM in the later growth period. This in turn influenced the physiological processes directly related to nitrogen fixation, photosynthesis and translocation of carbohydrates for fruit development. The availability of Ca from AFBM and RFBM could have increased the fruit set and better fruit weight through better canopy development. This would have also increased the efficiency of photosynthesis in the plants. Calcium also might have increased the activity of enzymes like phospholipase, arginine kinase, amylase and adenosine tri phosphatase (ATPase), which would have made them effective in better flowering, fruit set and yield of the crop. Similar results are also reported by Muhammad (2012), Tamilselvi *et al.* (2002) and Alia *et al.* (2015) in tomato.

Conclusion

Organic wastes contain valuable nutrients that promote crop growth, yield and soil environmental health. Both macro and micro-nutrients and other growth promoting substances are present in the wastes in various proportions that however depend on the type of waste. Application of fish bone meal in combination with mineral fertilizer significantly increased morphological characters like plant height and number of branches in all crop growth stages. From the present study, it can be concluded that the higher tomato growth, yield parameters and fruit yield was noticed with the application of 75 per cent of recommended P through mineral fertilizer and remaining through AFBM (T_5) compared to other treatments.

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Conflict of interest

The authors declare that they have no conflict of interest

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