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Effect of Controlled Release and Water Soluble Fertilizers on Nutrient (NPK) Uptake and Dry Matter Production of Chilli var. PKM-1

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Abstract: An investigation was carried out to find out the influence of controlled release fertilizers (CRF) and water soluble fertilizers (WSF) as NPK sources *vis-a-vis* standard fertilizers on the growth and nutrient uptake of chilli. To evaluate these products as nutrient sources to chilli grown on sandy loam soil, field experiment was conducted by applying CRF and WSF in comparison with standard fertilizers as control. The results revealed that application of CRF with WSF as per the recommended doses increased the production of dry matter and the uptake of nutrients in chilli compared to other treatments.

Keywords: Controlled release fertilizer, water soluble fertilizer, sandy loam.

INTRODUCTION

Uptake of nutrients from soil by crop plants is directly correlated with the enhanced yield, particularly in vegetable crop cultivation. Efficient use of available nutrients is more important than other production constraints in vegetable production. Application of controlled release and water soluble fertilizers are such approaches to enhance the nutrient availability. They continuously supply all the essential nutrients throughout the crop period and hence deserves use in vegetable production. Controlled-release fertilizers are such forms of fertilizers from which nutrient release into the environment occurs in a more or less controlled manner. They may be strongly affected by handling conditions such as storage, transportation and distribution in the field or by soil conditions such as moisture content, wetting and drying, thawing and freezing, and biological activity[14].

These fertilizers are expected to be effective in soils having a medium to high cation-exchange capacity where ammonium and other cationic nutrients are held in exchange positions[16]. Most of the organic-N based fertilizers are considered to be mainly controlled or slow releasing, involving many factors affecting their release. Urea formaldehyde, for example, releases available nitrogen slowly as a result of the degradation of oligometric chains.

The nutrient release pattern of two controlled release NPK sources *viz*., Agroblen and Micromax are designed to allow the fertilizer nutrients to dissolve and get released in the soil solution. There are many forms of controlled release fertilizers including those that are coated (osmocote, sulphur coated etc.) and chemically modified (ureaform or polyform etc.) which supply nutrients[4]. To this experiment the controlled release (CRF) NPK sources of fertilizers and chemicals used in the form of granules, mixtures and coated fertilizers which contain all the three major nutrients in them and secondary nutrients. In order to study the effect of these fertilizes on dry matter production and the uptake of nutrients by chilli as a test crop, this field experiment was conducted.

MATERIALS AND METHODS

A field experiment was conducted at Farmer's field in Thondamuthur, Coimbatore on sandy loamy soil with chilli as test crop. The pH and EC of the experimental soil were 8.3 and 0.18 dSm^{-1} respectively in 1:2.5 soil water suspension with an exchangeable sodium percentage (ESP) of 30. Organic carbon content was 0.51 % and exchangeable calcium was 4.4 cmol $(p^+)\ kg^{-1}$. The $KMnO_4$-N, Olsen-P and NH_4OAc-K level were 206,19and 401 $kgha^{-1}$, respectively. The field was prepared well and at the last ploughing, farmyard manure was applied (12.5 t ha^{-1}) and incorporated. The experiment was conducted with the following treatments with two replications in a randomized block design.Viz., 100 percent NPK recommended dose (120:60:30 kg ha^{-1}) as straight fertilizers applied in split doses (control), 50 percent NPK plus WSF (General Purpose and Plant Starter each at two levels as foliar spray), CRF (Micromax at two levels and Agroblen at three levels) alone as basal and CRF (Agroblen at three levels) basal plus WSF (General Purpose and Plant Starter each at two levels) as foliar spray at different intervals viz., weekly once

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Table 1: Effect of controlled release and water soluble fertilizers on N, P and K uptake (kg ha^{-1}) of chilli- Var. PKM-1

Treatments	Nitrogen			Phosphorus			Potassium		
	V	F	H	V	F	H	V	F	H
T1 - 100% NPK	2.05	30.0	60.9	1.144	4.88	8.80	2.24	40.9	73.5
T2 - 50% NPK + GP 1 g lit-1 FS	2.16	40.4	71.2	1.155	5.56	10.5	2.33	47.2	92.6
T3 - 50% NPK + GP 2 g lit-1 FS	2.23	35.5	74.5	1.159	5.61	11.4	2.39	47.7	96.5
T4 - 50% NPK + PS 1 g lit-1 FS	2.10	41.6	75.7	1.155	5.75	11.8	2.35	49.0	98.9
T5 - 50% NPK + PS 2 g lit-1 FS	2.28	44.6	78.5	1.167	6.13	10.7	2.43	52.1	104.0
T6 - Agroblen 10 g m-2	2.26	45.1	70.9	1.147	5.92	9.65	2.24	53.4	95.6
T7 - Agroblen 20 g m-2	2.29	49.8	75.5	1.167	6.39	12.5	2.43	57.7	104.1
T8 - Agroblen 30 g m-2	2.52	56.4	89.1	1.187	7.31	14.5	2.69	65.8	119.5
T9 - Agroblen 10 g m-2 + GP 1 g lit-1 FS	2.28	51.9	75.2	1.162	6.45	11.8	2.44	58.4	93.3
T10 - Agroblen 10 g m-2 + GP 2 g lit-1 FS	2.35	53.6	78.0	1.172	7.08	12.3	2.52	59.6	100.2
T11 - Agroblen 10 g m-2 + PS 1 g lit-1 FS	2.43	53.5	80.9	1.170	7.15	13.1	2.59	60.0	100.6
T12 - Agroblen 10 g m-2 + PS 2 g lit-1 FS	2.53	56.4	83.6	1.187	7.43	13.4	2.68	62.2	104.0
T13 - Agroblen 20 g m-2 + GP 1 g lit-1 FS	2.73	58.1	99.5	1.195	7.81	16.0	2.81	65.6	120.6
T14 - Agroblen 20 g m-2 + GP 2 g lit-1 FS	2.97	63.3	107.2	1.221	8.43	16.8	3.04	71.3	124.8
T15 - Agroblen 20 g m-2 + PS 1 g lit-1 FS	2.77	63.1	108.5	1.194	8.48	17.9	2.85	71.9	127.3
T16 - Agroblen 20 g m-2 + PS 2 g lit-1 FS	3.02	68.5	116.4	1.223	9.15	18.7	3.11	77.1	131.6
T17 - Agroblen 30 g m-2 + GP 1 g lit-1 FS	3.16	71.8	119.5	1.235	9.66	20.3	3.17	84.5	149.7
T18 - Agroblen 30 g m-2 + GP 2 g lit-1 FS	3.21	76.3	124.8	1.248	10.2	21.3	3.29	89.4	160.7
T19 - Agroblen 30 g m-2 + PS 1 g lit-1 FS	3.24	75.9	128.1	1.240	10.3	22.5	3.28	96.3	166.7
T20 - Agroblen 30 g m-2 + PS 2 g lit-1 FS	3.46	80.3	134.7	1.263	10.8	23.5	3.48	101.5	175.9
T21 - Micromax 10 g m-2	2.33	62.8	81.2	1.163	8.5	10.0	2.44	71.7	96.0
T22 - Micromax 20 g m-2	2.61	68.3	85.7	1.200	9.25	11.1	2.72	78.3	104.6
CD (P=0.05)	0.214	2.37	4.55	0.008	0.26	6.02	0.047	1.90	0.66

during 1st month, once in two weeks during 2nd and 3rd months and once in a month during 4th and 5th months throughout the crop growth period.

Five plants in each treatment were removed from the sample rows at different stages *viz.,* establishment, flowering and harvesting, air dried and then oven dried at 80 ± 2°C till constant weight was attained. Dry matter production was computed and expressed in kg ha^{-1}. The pod and dry matter samples were collected, processed and analyzed separately for major nutrients and respective uptake were computed for all the crop stages viz.,vegetative(V),fowering(F) and harvesting(H). The total N was estimated by following the procedure of microkjeldahl method[7]. In di-acid (nitric and perchloric in 9:4 ratio) digest, total P was estimated by vanadomolybdo phosphoric yellow color method and total K by flame photometry[8].

RESULTS AND DISCUSSIONS

Nutrient uptake is an important process, which decides all improvement in plant growth, yield and quality of crop produces. When CRF and WSF are applied the physical and chemical properties of the soil are improved as compared to commercial fertilizers[11] and the utilization of nutrients by plants at critical stages are also increased[12] as in CRF the release of nutrients is for an extended period[9].

The use of CRF might have allowed the nutrients to be used more efficiently by plants than soluble

Table 2: Effect of controlled release and water-soluble fertilizers on dry matter production (kg ha^{-1}) of chilli – Var.PKM-1

Treatments	Vegetative stage	Flowering stage	Harvesting stage
T_1 - 100% NPK	67.8	837	2764
T_2 - 50% NPK + GP 1 g lit^{-1} FS	68.4	1070	3277
T_3 - 50% NPK + GP 2 g lit^{-1} FS	71.4	1058	3387
T_4 - 50% NPK + PS 1 g lit^{-1} FS	69.5	1125	3413
T_5 - 50% NPK + PS 2 g lit^{-1} FS	73.3	1222	3527
T_6 - Agroblen 10 g m^{-2}	66.1	1305	3183
T_7 - Agroblen 20 g m^{-2}	73.0	1397	3373
T_8 - Agroblen 30 g m^{-2}	79.8	1603	3869
T_9 - Agroblen 10 g m^{-2} + GP 1 g lit^{-1} FS	70.3	1458	3325
T_{10} - Agroblen 10 g m^{-2} + GP 2 g lit^{-1} FS	72.6	1462	3405
T_{11} - Agroblen 10 g m^{-2} + PS 1 g lit^{-1} FS	75.2	1494	3449
T_{12} - Agroblen 10 g m^{-2} + PS 2 g lit^{-1} FS	77.5	1532	3501
T_{13} - Agroblen 20 g m^{-2} + GP 1 g lit^{-1} FS	80.6	1506	4209
T_{14} - Agroblen 20 g m^{-2} + GP 2 g lit^{-1} FS	89.3	1650	4334
T_{15} - Agroblen 20 g m^{-2} + PS 1 g lit^{-1} FS	79.8	1645	4337
T_{16} - Agroblen 20 g m^{-2} + PS 2 g lit^{-1} FS	88.5	1775	4449
T_{17} - Agroblen 30 g m^{-2} + GP 1 g lit^{-1} FS	90.1	1896	4603
T_{18} - Agroblen 30 g m^{-2} + GP 2 g lit^{-1} FS	93.0	2000	4749
T_{19} - Agroblen 30 g m^{-2} + PS 1 g lit^{-1} FS	90.4	2002	4783
T_{20} - Agroblen 30 g m^{-2} + PS 2 g lit^{-1} FS	95.8	2104	4832
T_{21} - Micromax 10 g m^{-2}	76.6	2114	4599
T_{22} - Micromax 20 g m^{-2}	88.5	2238	4564
CD (P=0.05)	4.51	57.4	66.4

conventional N fertilizers by reducing N leaching losses and providing a constant supply of nutrients to the roots[6,10]. All the reasons specified above might have enhanced the uptake of nutrients by plant when CRF is applied either alone or in combination with WSF.

Effect of CRF and WSF on Nutrient Uptake: Nutrient uptake was computed at establishment, flowering and post harvest stages. There was an increasing trend in the uptake of nutrient by the plants during the growth stages. The results are presented in Table 1. The effect of treatments was found to be significant at five per cent level in all the stages.

Nitrogen Uptake: The treatment T_{20} (3.46, 80.3 and 134.7 respectively in all the stages) recorded the highest uptake of nitrogen. The lowest uptake was recorded in T_4 (2.1 kg ha^{-1}) followed by T_1 (2.05 kg ha^{-1}) in establishment stage. At flowering stage treatment T_3 recorded the lowest uptake of nitrogen (35.5 kg ha^{-1}) followed by control (30.0 kg ha^{-1}). At post harvest stage the lowest uptake of nitrogen was recorded in T_6 (70.9 kg ha^{-1}) followed by T_1(60.9 kg ha^{-1}). This might be due to the gradual increase in the N released from the CRF in time for plant absorption particularly during its peak period of requirement[15]. In addition, the application of water-soluble fertilizers (general purpose and plant starter) might have met the nutrient demand of the crops as per their requirement.

Phosphorus Uptake: The phosphorus uptake by plants increased with crop growth. The increase in dry matter production coupled with higher N content might have enhanced the phosphorus uptake. P uptake was also computed at 3 stages *viz.*, establishment, flowering and post harvest stage. An increasing trend was noticed in P uptake at all the stages (Table 1). All the treatments recorded a higher uptake of P as compared to T_1 control treatment (1.144, 4.88 and 8.80 kg ha^{-1}) at all the stages. The highest P uptake was observed in T_{20} (1.263, 10.8 and 23.5 kg ha^{-1}) at all stages and this was followed by T_{18}, T_{19} and $T_{17,}$ respectively. The controlled release fertilizer (Agroblen) when used as a source of P, release the phosphorus to the soil medium at rates and concentrations that allow the growing plant to maintain maximum expression of its genetic capability[5]. Moreover the reduction of nutrient immobilization by the chemical and biological reactions might have enhanced the P release from controlled release fertilizer (Agroblen) at critical physiological stages and made it available to crops, thereby increasing the uptake of P[3].

The conversion of P to less available forms is negligible in CRF (because of the resin coating) as compared to soluble fertilizer (straight) which has an intimate contact with soil, thereby resulting in the conversion of P to unavailable forms[2, 13].

Potassium Uptake: At all the stages, the higher uptake of K was observed in T_{20} (3.48, 101.5 and 175.9 kg ha^{-1}) followed by T_{19} (3.28, 96.3 and 166.7 kg ha^{-1}) and T_{18} (3.29, 89.4 and 160.7 kg ha^{-1}). The least K uptake was in T_2 (2.33 kg ha^{-1}) followed by T_6 and T_1 (each recording 2.24 kg ha^{-1}) at establishment stage whereas at flowering and post harvest stages the K uptake was lower in T_2 (47.2, 92.6 kg ha^{-1}) followed by control treatment (40.9 and 73.5 kg ha^{-1}). Potassium is available in cationic form and its availability is governed by several factors, which in turn control the exchange equilibria in soil. At low pH, the K availability decreases as it depends on exchangeable potassium, potassium saturation, CEC and pH. It could also be ascribed to the longer nutrient release duration (because of resin coating) associated with its capability to meet the nutrient need of the crop[1].

Further its relatively extended period of nutrient release might have given rise to lower accumulation of salts in the root zone than did by soluble straight fertilizers. In other words the CRF minimizes the risk of damage to crops due to excess salinity.

Dry Matter Production: The total dry weight of the chilli plant increased from establishment to post harvest stage in all the treatments and the increase was maximum during flowering to post harvest stage. Control (100 per cent NPK) registered lower dry matter production than the other treatments. Higher dry matter production was evident in T_{20} (95.8 kg ha^{-1}) followed by T_{18}, T_{19} and T_{17} (93.0, 90.4 and 90.1 kg ha^{-1} respectively) at establishment stage. At flowering stage, the treatment T_{22} (2238 kg ha^{-1}) followed by T_{21} (2114 kg ha^{-1}) and T_{20} (2104 kg ha^{-1}) produced more dry matter. Even at the post harvest stage, the treatment T_{20} (4832 kg ha^{-1}) followed by T_{19} (4783 kg ha^{-1}) and T_{18} (4749 kg ha^{-1}) produced higher dry matter production as compared to all other treatments.

Conclusion: The investigation showed in general that the dry matter production and NPK uptake by chilli crop was higher with the soil application of agroblen 30g m^{-2} plus plant starter 2g lit^{-1} foliar spray compared to all other treatment combinations including control.

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