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## Relative Efficiency of Controlled Release and Water Soluble Fertilizers on the Yield and Quality of Chilli (*Capsicum annuum* Linn.)

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**Abstract:** A study was conducted at farmer's field Thondamuthur, Coimbatore district (11°N and 77°E) during (November-April) 1999-2000 in periyannayakkan palayam series, sandy loam soil to study the effect of Controlled Release Fertilizers (CRF) and Water Soluble fertilizers (WSF) as against the conventional Straight fertilizers on chilli yield and quality. The results revealed that the soil application of 50% NPK + WSF (PS at 1 or 2 g L<sup>-1</sup>) foliar spray found to be the best combination on the basis of cost benefit ratio (1:3.10 and 1:3.00) which had enhanced the green chilli yield (8.86 and 8.94 t ha<sup>-1</sup>, respectively) and quality viz., capsaicin (4.16 and 4.19 mg 100 g<sup>-1</sup>), ascorbic acid (92.9 and 93.2 mg 100 g<sup>-1</sup>), TSS (10.3 and 10.5°B), crude protein (10.3 and 10.5%) and crude fibre (18.6 and 18.8%), respectively as against the NPK control. Hence, the application of 50% NPK plus WSF foliar spray treatment combinations could enhance the production potential of chilli which in turn increases the net return to the farmers.

**Key words:** Controlled release fertilizer, foliar spray, water soluble fertilizer

### Introduction

Generally the yield and quality of crops depends largely on the soil fertility. Soil analyses revealed that the fertility of soil could be enhanced by resorting to the application of fertilizers. However to obtain the maximum yield and quality with economy, it is essential to make a very judicious and efficient use of fertilizers.

Among the various factors affecting the production of chillies, the role of fertilizers assumes a greater significance. The limited fertilizer resources including their higher cost warrant their judicious use for obtaining maximum efficiency. It has been demonstrated that the use of Controlled Release Fertilizers (CRFs) is a cost effective way of producing quality plants (Rauch and Murakami, 1994).

Several straight and water soluble fertilizers, used for improving the crop yield and quality, produce some negative (or) side effects besides, leaching losses, thus hindering the supply of nutrients required by crops at critical phases of crop growth period. To overcome this problem Slow Release Fertilizers (SRF) or Controlled Release Fertilizers (CRF) were introduced. Controlled release fertilizers improve the yield and quality of plant products invariably compared to that of conventional fertilizers. Recent reviews of the literature (Amans and Slangen, 1994; Morales, 1999) indicated the potential benefits of using CRFs to increase the fertilizer use efficiency. Controlled release fertilizers consist of water-soluble nutrient granules, coated with a semi permeable organic resin material. The coating controls the safe and reliable nutrient release without leaching problems even at high EC levels and available to the plants throughout the entire crop growth period. It needs only less labour, time and

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quantity input compared to other fertilizers (Shaviv and Mikkelson, 1993). Therefore, an attempt was made to study the relative efficiency of these fertilizers (CRF and WSF) as against the conventional NPK fertilizers on the yield and quality of chilli cv.PKM-1.

## **Materials and Methods**

The experiment was conducted in a slightly saline (pH 8.3 and EC 1.18 dS m<sup>-1</sup>) soil having low N, medium P and high K (206,19 and 401 kg ha<sup>-1</sup>) with the following treatments with three replications in Randomized Block Design. Viz., 100% NPK recommended dose as straight fertilizers (control), 50% NPK plus WSF (GP and PS 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 (GP and PS each at two levels) as foliar spray at different intervals viz., weekly once 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 during November-April (1999-2000).

The water-soluble fertilizer was mixed with required quantity of water and applied (0.1 and 0.2%) as foliar spray through hand and knapsack sprayer while the CRF was applied in the soil directly by making holes using iron rod at 5-10 cm depth adjacent to the root zone of the plant. The NPK status of CRF Agroblen and Micromax were 20:10:10 and 15:25:10 and WSF viz., General Purpose and Plant Starter having the NPK grade of 20:20:20 and 10:52:10, respectively. The recommended dose of NPK for chilli is at the rate of 120:60:30 kg ha<sup>-1</sup> the N was applied in 3 splits skipping basal i.e., 40 kg N at 30, 60 and 90 DAT. The field was prepared well and at the last ploughing farmyard manure was applied (12.5 t ha<sup>-1</sup>) and incorporated. PKM-1 variety chilli was used as test crop, where the seedlings were transplanted in the main field and maintained up to 210 days for taking six pickings and the yield was recorded.

The quality parameters analysed (red riped pods) viz., TSS using *Zeiss* Hand Refractometer, Porter (1960), Ascorbic acid (Titration method using 2, 6-dichlorophenol indophenol dye) Freed (1966), Capsaicin (Balasubramaniam *et al.*, 1982), Crude protein (Humphries, 1956) and crude fibre by acid alkali digestion method suggested by Chopra and Kanwar (1976).

## **Results and Discussion**

### *Effect of Treatments on Chilli Pod Yield (t ha<sup>-1</sup>) and Cost Benefit Ratio*

The chilli (green) pod yield in Table 1 revealed that there was non-significant impact of controlled release fertilizers and water soluble fertilizers when applied either through soil or through foliar application individually. Whereas combined application of soil plus foliar gave the impressive result viz., the soil application of agroblen at the rate of 30 g m<sup>-2</sup> plus PS 2 g L<sup>-1</sup> registered the yield of 10.3t ha<sup>-1</sup>(T<sub>20</sub>). Which was closely followed by agroblen 30 g m<sup>-2</sup> plus PS 1 g L<sup>-1</sup> FS (9.9 t ha<sup>-1</sup>) (T<sub>19</sub>) and agroblen 30 g m<sup>-2</sup> plus GP 2 g L<sup>-1</sup> FS (9.7 t ha<sup>-1</sup>) (T<sub>18</sub>) treatments. This might be due to the increased availability of nutrients due to the controlled release nature of the fertilizer material throughout crop growth period. However, the yield obtained with application of 50% NPK plus WSF (GP/PS each at 1 or 2 g L<sup>-1</sup>) (T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>) was similar to that obtained with basal application of CRF (Agroblen or Micromax each at 10 or 20 g m<sup>-2</sup>) and superior to control (T<sub>1</sub>) treatment which recorded the yield of (7.85 t ha<sup>-1</sup>). The CRF Micromax applied at 20 g m<sup>-2</sup> (8.9 t ha<sup>-1</sup>) surpassed the application of Micromax at 10 g m<sup>-2</sup> (8.03 t ha<sup>-1</sup>) and Agroblen at 10 and 20 g m<sup>-2</sup> (8.06 and 8.50 t ha<sup>-1</sup>). So, the yield obtained with application of 50% NPK plus WSF (GP/PS each at 1 or 2 g L<sup>-1</sup>) ranged from 8.73 to 8.94 t ha<sup>-1</sup> (T<sub>2</sub> to T<sub>5</sub>) was superior in improving the yield of chillies compared to the application of Agroblen at 10 g m<sup>-2</sup> along with WSF (7.7 to 7.83 t ha<sup>-1</sup>) and control treatment (7.85 t ha<sup>-1</sup>).

**Table 1: Effect of controlled release fertilizers and water-soluble fertilizers on green chilli yield ( $t\ ha^{-1}$ ) and cost benefit ratio**

Treatments	Yield ( $t\ ha^{-1}$ )	B : C ratio
T <sub>1</sub> . 100% NPK	7.85	1:2.23
T <sub>2</sub> . 50% NPK + GP 1 $g\ L^{-1}$ FS	8.73	1:3.06
T <sub>3</sub> . 50% NPK + GP 2 $g\ L^{-1}$ FS	8.80	1:2.96
T <sub>4</sub> . 50% NPK + PS 1 $g\ L^{-1}$ FS	8.86	1:3.1
T <sub>5</sub> . 50% NPK + PS 2 $g\ L^{-1}$ FS	8.94	1:3.0
T <sub>6</sub> . Agroblen 10 $g\ m^{-2}$	8.06	1:1.47
T <sub>7</sub> . Agroblen 20 $g\ m^{-2}$	8.50	1:1.09
T <sub>8</sub> . Agroblen 30 $g\ m^{-2}$	9.02	1:0.88
T <sub>9</sub> . Agroblen 10 $g\ m^{-2}$ + GP 1 $g\ L^{-1}$ FS	7.70	1:1.34
T <sub>10</sub> . Agroblen 10 $g\ m^{-2}$ + GP 2 $g\ L^{-1}$ FS	7.78	1:1.30
T <sub>11</sub> . Agroblen 10 $g\ m^{-2}$ + PS 1 $g\ L^{-1}$ FS	7.74	1:1.35
T <sub>12</sub> . Agroblen 10 $g\ m^{-2}$ + PS 2 $g\ L^{-1}$ FS	7.83	1:1.31
T <sub>13</sub> . Agroblen 20 $g\ m^{-2}$ + GP 1 $g\ L^{-1}$ FS	8.77	1:1.09
T <sub>14</sub> . Agroblen 20 $g\ m^{-2}$ + GP 2 $g\ L^{-1}$ FS	9.05	1:1.09
T <sub>15</sub> . Agroblen 20 $g\ m^{-2}$ + PS 1 $g\ L^{-1}$ FS	9.45	1:1.17
T <sub>16</sub> . Agroblen 20 $g\ m^{-2}$ + PS 2 $g\ L^{-1}$ FS	9.53	1:1.15
T <sub>17</sub> . Agroblen 30 $g\ m^{-2}$ + GP 1 $g\ L^{-1}$ FS	9.50	1:0.91
T <sub>18</sub> . Agroblen 30 $g\ m^{-2}$ + GP 2 $g\ L^{-1}$ FS	9.70	1:0.91
T <sub>19</sub> . Agroblen 30 $g\ m^{-2}$ + PS 1 $g\ L^{-1}$ FS	9.90	1:0.95
T <sub>20</sub> . Agroblen 30 $g\ m^{-2}$ + PS 2 $g\ L^{-1}$ FS	10.3	1:0.94
T <sub>21</sub> . Micromax 10 $g\ m^{-2}$	8.03	1:1.51
T <sub>22</sub> . Micromax 20 $g\ m^{-2}$	8.90	1:1.14
CD ( $p = 0.05$ )	0.19	

The cost benefit ratio was worked out based on the crop yield of (green) chilli (Table 1). The cost benefit ratio ranged from 1: 0.88 in agroblen at 30  $g\ m^{-2}$  (T<sub>8</sub>) to 1:3.10 in 50% NPK plus WSF PS at 1  $g\ L^{-1}$  (T<sub>4</sub>). Between the two CRF tried Micromax had higher cost benefit ratio ranging from 1:1.14 to 1:1.51 as against Agroblen at different levels (1:0.88 to 1:1.35). The control treatment (T<sub>1</sub>) recorded a cost benefit ratio of 1:2.23 which was higher than that obtained for the basal application of CRF (Agroblen 1: 0.88 to 1:1.35 or Micromax 1:1.14 to 1:1.51) alone or the basal application of CRF along with WSF (GP or PS each at 1 or 2  $g\ L^{-1}$ ; 1:1.16 to 1:1.18).

#### *Effect of Treatments on Quality Parameters*

The experiment results (Table 2a and b) revealed that the soil application of CRF agroblen 30  $g\ m^{-2}$  plus WSF Plant starter 2  $g\ L^{-1}$  (T<sub>20</sub>) as foliar spray significantly enhanced the quality of red ripe pods of chillies through registering higher level of capsaicin (4.26  $mg\ 100\ g^{-1}$ ) i.e., 3.9% increase over control, which might have influenced by nitrogen uptake, as nitrogen is one of the constituents of capsaicin (C<sub>18</sub>H<sub>27</sub>NO<sub>3</sub>) (Quagliotti, 1971). Ascorbic acid (127.0  $mg\ 100\ g^{-1}$ ) this might be due greater nutrient uptake by plant and fruits, which are interlocked with enzymatic mechanisms that activated the nutrient metabolisms (Hegde and Srinivas, 1990), total soluble solids (12.3°B), crude protein (12.8%) and crude fibre (25.0%) influenced by nitrogen uptake, respectively. The fruit quality of this treatment (T<sub>20</sub>) was found to be superior to the quality of fruit obtained from all other treatments.

However, the treatments agroblen 30  $g\ m^{-2}$  plus GP 2  $g\ L^{-1}$  FS (T<sub>18</sub>), agroblen 30  $g\ m^{-2}$  plus PS 1  $g\ L^{-1}$  FS (T<sub>19</sub>) and agroblen 30  $g\ m^{-2}$  plus GP 1  $g\ L^{-1}$  FS (T<sub>17</sub>) were on par with each other and at agroblen 30  $g\ m^{-2}$  plus PS 2  $g\ L^{-1}$  statistically (Table 2a and b). While the application of 50% NPK plus WSF (GP or PS at the rate of 1 or 2  $g\ L^{-1}$  as foliar spray though recorded higher yield, the quality of fruit seems to superior than control through enhanced the capsaicin content by 2.2% over NPK control. Similar results were also reported by Ferguson (1980). Between the two CRF and two WSF tried Agroblen proved its superiority over Micromax and Plant Starter proved its superiority over General Purpose in enhancing the quality of chilli pods, respectively. The uptake of N and K are important for enhancing the quality of fruits as reported by Whight *et al.* (1962) which was proved by the controlled release and water soluble fertilizers tested in this experiment.

**Table 2a: Effect of controlled release fertilizers and water-soluble fertilizers on quality of chilli (Var.PKM-I)**

Treatments	TSS (°Brix)	Ascorbic acid (mg 100 g <sup>-1</sup> )	Capsaicin (mg 100 g <sup>-1</sup> )
T <sub>1</sub> . 100% NPK	9.8	90.1	4.10
T <sub>2</sub> . 50% NPK + GP 1 g L <sup>-1</sup> FS	10.3	91.8	4.15
T <sub>3</sub> . 50% NPK + GP 2 g L <sup>-1</sup> FS	10.4	92.2	4.17
T <sub>4</sub> . 50% NPK + PS 1 g L <sup>-1</sup> FS	10.3	92.9	4.16
T <sub>5</sub> . 50% NPK + PS 2 g L <sup>-1</sup> FS	10.5	93.2	4.19
T <sub>6</sub> . Agroblen 10 g m <sup>-2</sup>	10.3	94.6	4.13
T <sub>7</sub> . Agroblen 20 g m <sup>-2</sup>	10.7	96.3	4.18
T <sub>8</sub> . Agroblen 30 g m <sup>-2</sup>	10.9	98.4	4.20
T <sub>9</sub> . Agroblen 10 g m <sup>-2</sup> + GP 1 g L <sup>-1</sup> FS	10.4	97.7	4.14
T <sub>10</sub> . Agroblen 10 g m <sup>-2</sup> + GP 2 g L <sup>-1</sup> FS	10.6	98.3	4.14
T <sub>11</sub> . Agroblen 10 g m <sup>-2</sup> + PS 1 g L <sup>-1</sup> FS	10.5	100.2	4.15
T <sub>12</sub> . Agroblen 10 g m <sup>-2</sup> + PS 2 g L <sup>-1</sup> FS	10.7	101.9	4.16
T <sub>13</sub> . Agroblen 20 g m <sup>-2</sup> + GP 1 g L <sup>-1</sup> FS	11.2	113.6	4.18
T <sub>14</sub> . Agroblen 20 g m <sup>-2</sup> + GP 2 g L <sup>-1</sup> FS	11.3	115.4	4.19
T <sub>15</sub> . Agroblen 20 g m <sup>-2</sup> + PS 1 g L <sup>-1</sup> FS	11.3	116.8	4.20
T <sub>16</sub> . Agroblen 20 g m <sup>-2</sup> + PS 2 g L <sup>-1</sup> FS	11.5	117.4	4.21
T <sub>17</sub> . Agroblen 30 g m <sup>-2</sup> + GP 1 g L <sup>-1</sup> FS	11.8	125.6	4.23
T <sub>18</sub> . Agroblen 30 g m <sup>-2</sup> + GP 2 g L <sup>-1</sup> FS	12.2	126.8	4.25
T <sub>19</sub> . Agroblen 30 g m <sup>-2</sup> + PS 1 g L <sup>-1</sup> FS	12.0	125.7	4.24
T <sub>20</sub> . Agroblen 30 g m <sup>-2</sup> + PS 2 g L <sup>-1</sup> FS	12.3	127.0	4.26
T <sub>21</sub> . Micromax 10 g m <sup>-2</sup>	10.5	87.4	4.12
T <sub>22</sub> . Micromax 20 g m <sup>-2</sup>	10.9	89.3	4.16
CD (p = 0.05)	0.296	0.054	0.073

**Table 2b: Effect of controlled release fertilizers and water-soluble fertilizers on quality of chilli (Var.PKM-I)**

Treatments	Crude protein (%)	Crude fibre (%)
T <sub>1</sub> . 100% NPK	9.30	18.4
T <sub>2</sub> . 50% NPK + GP 1 g L <sup>-1</sup> FS	10.1	18.7
T <sub>3</sub> . 50% NPK + GP 2 g L <sup>-1</sup> FS	10.4	18.9
T <sub>4</sub> . 50% NPK + PS 1 g L <sup>-1</sup> FS	10.3	18.6
T <sub>5</sub> . 50% NPK + PS 2 g L <sup>-1</sup> FS	10.5	18.8
T <sub>6</sub> . Agroblen 10 g m <sup>-2</sup>	10.6	17.9
T <sub>7</sub> . Agroblen 20 g m <sup>-2</sup>	10.8	18.3
T <sub>8</sub> . Agroblen 30 g m <sup>-2</sup>	11.2	18.5
T <sub>9</sub> . Agroblen 10 g m <sup>-2</sup> + GP 1 g L <sup>-1</sup> FS	10.7	18.4
T <sub>10</sub> . Agroblen 10 g m <sup>-2</sup> + GP 2 g L <sup>-1</sup> FS	10.8	18.7
T <sub>11</sub> . Agroblen 10 g m <sup>-2</sup> + PS 1 g L <sup>-1</sup> FS	11.0	18.6
T <sub>12</sub> . Agroblen 10 g m <sup>-2</sup> + PS 2 g L <sup>-1</sup> FS	11.1	19.2
T <sub>13</sub> . Agroblen 20 g m <sup>-2</sup> + GP 1 g L <sup>-1</sup> FS	11.1	19.4
T <sub>14</sub> . Agroblen 20 g m <sup>-2</sup> + GP 2 g L <sup>-1</sup> FS	11.4	20.6
T <sub>15</sub> . Agroblen 20 g m <sup>-2</sup> + PS 1 g L <sup>-1</sup> FS	11.1	20.9
T <sub>16</sub> . Agroblen 20 g m <sup>-2</sup> + PS 2 g L <sup>-1</sup> FS	11.5	21.7
T <sub>17</sub> . Agroblen 30 g m <sup>-2</sup> + GP 1 g L <sup>-1</sup> FS	11.5	22.9
T <sub>18</sub> . Agroblen 30 g m <sup>-2</sup> + GP 2 g L <sup>-1</sup> FS	11.8	24.6
T <sub>19</sub> . Agroblen 30 g m <sup>-2</sup> + PS 1 g L <sup>-1</sup> FS	12.5	23.3
T <sub>20</sub> . Agroblen 30 g m <sup>-2</sup> + PS 2 g L <sup>-1</sup> FS	12.8	25.0
T <sub>21</sub> . Micromax 10 g m <sup>-2</sup>	11.1	18.2
T <sub>22</sub> . Micromax 20 g m <sup>-2</sup>	11.5	18.7
CD (p = 0.05)	0.283	0.365

## Conclusions

The yield and quality of chilli enhanced by the controlled release fertilizers with water soluble fertilizers is more, its cost-benefit ratio is considerably less as compared to that of 50% NPK with WSF. Hence, application of 50% NPK along with water soluble fertilizers is beneficial in increasing chilli pod yield and its quality. Hence, these combinations of fertilizer application might be recommended to the farmers.

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