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FIELD EFFICACY OF PRIME MNF 15-5-20 ON HYBRID TOMATO

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Abstract:
This study presents the findings of a field efficacy evaluation for the growth and yield of hybrid tomatoes as influenced by Prime MNF 15-5-20 granular fertilizer. Prime MNF 15-5-20 consists mainly of 10-30% ammonium nitrate, but although its total nitrogen of 40%, it only has 14.5% available nitrogen. It also has 5% phosphate, 20% potassium, 15% chloride, 4% sulfur, 0.02% boron, and 0.02% zinc. With these available nutrients, it is believed that the product can supply the nutrients needed for the optimal growth of tomatoes. This study aimed to assess the bio-efficacy of Prime MNF 15-5-20 on the growth and yield performance of tomatoes in farmer's fields. The experiment followed a randomized complete block design with three replications, with the granular fertilizer treatments applied at three growing periods – 21 days, 35 days, and 42 days after transplanting. Parameters such as, the number of fruits/plant, number of marketable fruits per plant, the weight of marketable fruits per plant, computed yield per hectare, and number of primings were recorded, and analyzed statistically. The study revealed that the application of a double dose and single dose of Prime MNF 15-5-20, and inorganic fertilizer alone is significantly different from the half dose of Prime MNF 15-5-20 and the control. In terms of the computed yield per hectare, the application of Prime MNF 15-5-20, at any rate, would benefit farmers with higher yields. Its application has resulted in a yield advantage of 0.55-5.4 tons over the control. These values could be translated to higher economic gains if the product is used at higher dosages. The yield differences could be translated to Php 41,530.80-53,186.80 per hectare additional income to the farmers if Prime MNF 15-5-20 is used instead of the conventional inorganic fertilizer.

Keywords: tomato, Prime MNF 15-5-20, field efficacy, yield

1. INTRODUCTION

Tomato (*Solanum lycopersicum*) is a flowering plant of the nightshade family (Solanaceae), cultivated extensively for its edible fruits, and labeled as a vegetable for nutritional purposes, as it is a reliable source of vitamin C (Britannica, 2023). It is a vegetable crop that is cultivated all over the world and is a reliable source of vitamins A, B6, C, K, E (Adekiya et al., 2022), and the phytochemical lycopene (Britannica, 2023). It also contains molybdenum, copper, potassium, and manganese, and is a reliable source of dietary fiber (Adekiya et al., 2022). The fruits are commonly eaten raw in salads, served as a cooked vegetable, used as an ingredient in various prepared dishes, and pickled. Moreover, a significant percentage of the world's tomato crop is used for processing; products that include canned tomatoes, tomato juice, ketchup, puree, paste, and "sun-dried" tomatoes or dehydrated pulp.

Tomato is a seasonal fruit vegetable grown in almost all parts of the Philippines. Although it ranks second to eggplant in terms of total production area, seasonality of production, and limited domestic supply continue to plague the industry. The fruit is used as an ingredient in many food preparations and is regarded as one of the most profitable crops for off-season production, preferably from May to September. Tomatoes come in many different types of fruit—fresh or beefsteak types, grape, saladette, cherry, plum or paste, and others. Producing a mixture of these types may expand marketing capabilities and prospects. However, the successful production of tomatoes requires increasing yield and fruit quality.

Fertilization can provide necessary and sufficient nutrients for crop growth and is a universal agricultural means to ensure high crop yields (Hernandez et al., 2014). Tomatoes are heavy feeders that generally need quite a bit of fertilizer to get them through the season (PRO-MIX, n.d.), and the tricky part is figuring out which fertilizer is best, how much to use, and when to apply it. When fertilizing tomato plants, attention should be to the levels of nitrogen (N), phosphorus (P), and potassium (K) being applied. Some growers prefer to use a high-phosphorus fertilizer, indicated by a larger middle number. Fertilizers especially formulated for tomatoes will usually have a ratio of 3-4-6 or 4-7-10. (N-P-K). It is always important to remember not to over-fertilize since too little fertilizer is always better than too much.

According to Adekiya et al. (2022), inorganic fertilizer enhances the performance and mineral concentrations of tomato fruits in comparison with organic fertilizer. However, their leaf analyses showed that all the essential elements for tomatoes were within the adequate ranges in the organic fertilizer treatments, suggesting that this organic fertilizer can be used as an alternative to the expensive and scarce inorganic fertilizer. Wu et al. (2022) reported that 100% inorganic fertilizer application could increase tomato yield by 72.9% (1.17 ± 0.31 kg pot^{-1}), but the soil quality was remarkably degraded. So, it suggested that the combined use of 25% cow manure and 75% inorganic fertilizer was the best condition for tomato production, explained by a balanced soil physicochemical variables and microbial nitrification process.

Prime MNF 15-5-20 is a granular fertilizer consisting mainly of 10-30% ammonium nitrate, however, the total nitrogen is 40% with only 14.5% available nitrogen. The complete analysis also shows that Prime MNF also has 5% phosphate, 20% potassium, 15% chloride, 4% sulfur, 0.02% boron, and 0.02% zinc. With these available nutrients, it is believed that the product can supply the nutrients needed for the optimal growth of tomatoes. Prime MNF 15-5-20 is one of the fertilizer products of Kingenta, a trusted fertilizer company in China. According to Kingenta, the product can increase yields, produce healthier plants, and reduce the cost of production, thus, this trial was done to validate their claims.

The study was conducted to evaluate the bio-efficacy of Prime MNF 15-5-20 on the growth and yield of tomatoes in farmers' fields and to make the product available to Filipino farmers.

2. MATERIALS AND METHODS

2.1 Study site: The research experiment was in Brgy. Puypuy, Bay, Laguna, and the duration was from October 2018 to January 2019 for one season.

2.2 Seedling Preparation: Tomato seeds were sown directly on seedling trays. A commercial tomato variety Diamante Max was used as the test crop/variety. Soil mix was prepared using compost and garden soil. One seed per hole was sown in the seedling trays and covered lightly with potting media. The sown seeds were watered and then sprinkled with appropriate insecticide (e.g., Carbomax 3G) to prevent insect damage. The seedling trays were saturated for the first three succeeding days and regulated watering after germination. A week after sowing, the germinated seedlings were drenched with foliar fertilizer (e.g., Yield Master 19-19-19 at 4 tbsp/16L water). Drenching was done late in the afternoon to avoid leaf burning. The seedlings were drenched again after 6 days using 10 tbsp of dissolved complete fertilizer in 16 L of water. The land was thoroughly prepared for good seedling establishment and weed control. At least 1 plowing and 1 harrowing was done.

2.3 Soil Analysis: After the first land plowing, surface (0-15 cm) soil samples were randomly collected from five different points on the experimental site for physical and chemical analysis. A complete soil physical and chemical analysis was requested from an accredited soil laboratory. The organic matter, nitrogen, phosphorus, and potassium levels were determined while moisture and pH were also measured.

2.4 Plot Preparation: Small plots measuring 4x5 m2 were made manually using spades, serving as replicates. A total of 15 plots were established. Each plot was covered with mulch.

2.5 Experimental Design and Treatment Application: The experiment followed a randomized complete block design with three replications. For the treatments, the granular fertilizers were applied in three growing periods – 21 days, 35 days, and 42 days after transplanting. The following treatments were used:

Table 1. Treatment assignment for the bioefficacy trial of Prime MNF 15-5-20 fertilizer.

Treatments	Fertilizer used*
1	1rr Inorganic Fertilizer (200 kg/ha 14-14-14 @ 21 and 42 DAT) (250 kg/ha 46-0-0 @ 21 and 35 DAT) (300 kg/ha 0-0-60 @ 35 and 42 DAT)
2	1RR Prime MNF 15-5-20 (100 kg/ha @ 21, 35 and 42 DAT)
3	½RR Prime MNF 15-5-20 (50 kg/ha @ 21, 35 and 42 DAT)
4	2RR Prime MNF 15-5-20 (200 kg/ha @ 21, 35 and 42 DAT)
5	Control

2.6 Hardening: The seedlings were hardened at least 2-4 days before transplanting. This was done by regulating the water and fertilizer application and exposing the seedlings to full sunlight to enable the plants to withstand stress during transplanting.

2.7 Transplanting: Healthy seedlings with 3-5 leaves 3 weeks after seedling emergence were selected for transplanting. One seedling per hill spaced 75 cm x 50 cm apart were transplanted in the field late in the afternoon. The seedlings were watered immediately. Missing hills were replanted 5-7 days after transplanting.

2.8 Irrigation: The plants were watered every day due to the hot conditions. Optional twice-a-day watering was done depending on the soil condition.

2.6 Pest Control: Insect pests and diseases of tomatoes were managed using chemical, biological, and remedial measures.

2.6.1 Insect Control: For the control of fruit borers, tricho cards were installed in the tomato field. Earwigs were released to control other insects while sticky traps were installed to control flying insect pests. Chemical insecticides to control aphids, cutworms, leafminers, thrips, whiteflies, leafhoppers, flea beetles, leafhoppers, and fruit flies were also applied.

2.6.2 Disease Control: Regular monitoring of the tomato plants was done to prevent disease outbreaks. Infected plants showing unusual signs such as curling, or mosaic were immediately removed and burned. Fungicides were also applied as preventive measures.

2.6.3 Weed Control: Plastic mulch was used to control weeds. Spot weeding was also done.

2.7 Harvesting: The tomato was harvested at the green stage started at approximately 60-65 days after transplanting. Twelve primings were done to harvest all the fruits.

2.8 Data Gathering: Data was gathered during the harvest period.

2.8.1 Number of fruits/plant: Harvest all the fruits from the 10 tagged randomly selected sample plants per net plot of 2x3m or 6m^2.

2.8.2 Number of marketable fruits/plant: Count the number of good quality fruits per plant.

2.8.3 Weight of marketable fruits/plant: Weight of good quality fruits per plant.

2.8.4 Yield per hectare: Convert kilogram yield per plot to tons per hectare.

2.9 Data Analysis and Interpretation: The generated data was subjected to statistical analysis using SAS portable version. Analysis of variance and treatment mean comparison using Tukey's Test was done at 5% probability level.

Two-way tables were prepared to show the means and their corresponding alphabet notations. Interpretations were done by comparing each treatment, especially with the control. Conclusions and recommendations were formulated based on the results generated.

3. RESULTS

3.1 Number of fruits per plant

The mean number of fruits per plant is shown in Table 1. Data shows that the highest number of fruits was obtained in the plants treated with a double dose of Prime MNF 15-5-20 with a yield advantage of 5 fruits per plant over the control. This is followed by the plants treated with the full recommended rate of Prime MNF 15-5-20 with a similar yield advantage of 5 fruits per plant over the control. The plants treated with inorganic fertilizer alone gave a yield advantage of 4 fruits per plant over the control. On the other hand, the plants treated with a half-dose recommended rate of Prime MNF 15-5-20 are not significantly different from the control plants. The control gave the lowest number of fruits per plant which is significantly different from the plants treated with twice and full recommended rate of Prime MNF 15-5-20 and full inorganic fertilizer alone.

Table 1. Mean number of fruits per plant

	Treatments	Fruit/plant			Mean
		1	2	3	
1	1rr Inorganic Fertilizer	15.60	17.50	16.50	16.53 A
2	1RR Prime MNF 15-5-20	17.40	17.20	18.40	17.67 A
3	½RR Prime MNF 15-5-20	15.00	14.50	13.70	14.40 B
4	2RR Prime MNF 15-5-20	18.80	17.00	17.80	17.87 A
5	Control	12.40	12.80	12.20	12.47 B

cv 4.61 p>0.0001 *Means with the same letter are not significantly different at α=0.05

3.2 Number of marketable fruits per plant

The mean number of marketable fruits per plant is summarized in Table 2. Data shows that the highest number of marketable fruits was obtained in the plants treated with a double dose of Prime MNF 15-5-20 with a yield advantage of 6 fruits per plant over the control. This is followed by the plants treated with a full dose of Prime MNF 15-5-20 with a similar yield advantage of 5 fruits per plant over the control. The plants treated with inorganic fertilizer alone gave a yield advantage of four fruits per plant over the control. On the other hand, the plants treated with half a dose of Prime MNF 15-5-20 are not significantly different from the control. The control gave the lowest number of fruits per plant, significantly different from the plants treated with twice and full doses of Prime MNF 15-5-20 and full inorganic fertilizer alone.

Table 2. Mean number of marketable fruits per plant

	Treatments	Fruit/plant			Mean
		1	2	3	
1	1rr Inorganic Fertilizer	16.20	16.00	14.20	15.47 A
2	1RR Prime MNF 15-5-20	13.40	17.20	18.80	16.47 A
3	½RR Prime MNF 15-5-20	12.50	12.60	12.10	12.40 B
4	2RR Prime MNF 15-5-20	17.20	18.60	17.20	17.67 A
5	Control	12.80	10.00	11.80	11.53 B

cv 5.79 p>0.0002 *Means with the same letter are not significantly different at α=0.05

3.3 Weight of marketable fruits per plant

The mean weights of marketable fruits per plant are shown in Table 3. The heaviest marketable fruits per plant were obtained in the plants treated with a double dose of Prime MNF 15-5-20, followed by the plants treated with a full dose of inorganic fertilizer, full dose of Prime MNF 15-5-20, and half dose of Prime MNF 15-5-20. The application of a double dose of Prime MNF 15-5-20 is comparable with the application of a full dose of Prime MNF 15-5-20 and inorganic fertilizer alone, but significantly different from the plants treated with a half dose of Prime MNF 15-5-20. The lightest marketable weight was obtained from the control and is comparable only to the plants treated with half-dose Prime MNF 15-5-20.

Table 3. Mean weights of marketable fruits per plant (gram/plant)

	Treatments	Fruit/plant			Mean
		1	2	3	
1	1rr Inorganic Fertilizer	686.40	688.80	610.20	661.80 A
2	1RR Prime MNF 15-5-20	630.40	641.80	630.40	634.20 A
3	½RR Prime MNF 15-5-20	570.00	570.40	527.20	555.87 B
4	2RR Prime MNF 15-5-20	664.80	663.20	658.40	662.13 A
5	Control	535.00	513.40	535.20	527.87 B

cv 3.91 $p>0.0001$ *Means with the same letter are not significantly different at $\alpha=0.05$

3.4 Yield per hectare

The computed yield per hectare for each treatment is summarized in Table 4. The data shows that the highest yields were derived from the plants treated with a double dose of Prime MNF 15-5-20 with a yield advantage of more than 5,400 kilograms per hectare over the control. This is followed by the plots treated with the full dose of Prime MNF 15-5-20 with a yield advantage of more than 5,110 kilograms per hectare over the control. While those treated with the full dose of inorganic fertilizer have a yield advantage of more than 4,070 kilograms per hectare over the control. The treatments with half dosage of Prime MNF 15-5-20 gave a lower yield relative to both the full dosage of Prime MNF 15-5-20 and the full dosage of inorganic fertilizer alone. Despite these differences, the application of double dose and full dose of Prime MNF 15-5-20 and full dosage of inorganic fertilizer are not significantly different from each other except for the plants treated with half dosage Prime MNF 15-5-20 and the control plants.

The results revealed that the tomato plants responded better with the supplementation of double dose Prime MNF 15-5-20 compared with the application of inorganic fertilizer alone, however, their means are not significantly different from each other. The higher levels of nitrogen and potassium have little advantage in tomato fertilization in this case although the area is deficient in all the major nutrients. Nevertheless, supplementation of a double dose of Prime MNF 15-5-20 has greatly increased tomato fruit yields relative to the rest of the treatments. Another advantage of Prime MNF 15-5-20 is the presence of micronutrients that are necessary for the productivity of tomato plants.

Table 4. Computed yield per hectare (kilogram/ha)

	Treatments	Fruit Weight/ha			Mean
		1	2	3	
1	1rr Inorganic Fertilizer	18,527.60	19,676.80	20,280.00	19,494.80 A
2	1RR Prime MNF 15-5-20	22,885.20	20,009.60	18,704.40	20,533.07 A
3	½RR Prime MNF 15-5-20	15,844.40	15,818.40	16,255.20	15,972.67 B
4	2RR Prime MNF 15-5-20	20,404.80	21,242.00	20,826.00	20,824.27 A
5	Control	15,776.80	15,342.60	15,145.00	15,421.47 B

cv 5.80 $p>0.0002$ *Means with the same letter are not significantly different at $\alpha=0.05$

4. DISCUSSION AND CONCLUSION

A field efficacy trial was conducted to determine the efficacy of Prime MNF 15-5-20 on the fresh yield of hybrid tomato, Diamante Max, for its registration to FPA as a granular fertilizer for tomato production. The results of the efficacy trial (Appendix Figure 3a-e) revealed that in terms of all the parameters measured, it consistently revealed that the application of a double dose and a single dose of Prime MNF 15-5-20 and inorganic fertilizer alone are significantly different with the half dose of Prime MNF 15-5-20 and the control.

In terms of the computed yield per hectare, a significant difference was shown in the statistical analysis, the application of Prime MNF 15-5-20 at any rate would benefit farmers with higher yields. Its application has resulted in a yield advantage of 0.55-5.4 tons over the control. These values could be translated to higher economic gains if the product is used at higher dosages. Based on the prevailing farm gate price (January 2019) of Php 40.00 per kilogram, the yield differences could be translated to Php 41,530.80-53,186.80 per hectare additional income to the farmer if Prime MNF 15-5-20 is used instead of the conventional inorganic fertilizer.

Likewise, the application of Prime MNF 15-5-20 can even reduce the application of inorganic fertilizer. Its application provided a yield advantage of more than 5 tons per hectare over the control. Although the yield in half dose is lower than the yield applied with a full dose of inorganic fertilizer, the yield obtained is still better than the yield in the control plants.

In previous investigations, results have shown that yield and quality parameters of tomato fruit were significantly affected by the combined use of compost and inorganic fertilizers (Khan et al., 2019, Al-Munsur et al., 2019), where maximum tomato fruit and dry matter yields, fruit density, number of fruit kg-1, N, P and K uptake by tomato plant were obtained from treatment where full dose of N, P and K with added compost applied. Furthermore, maximum vitamin C content in tomato fruit was observed where full doses of compost and mineral fertilizers were applied. Soil organic matter and N, P, and K contents were improved when full doses of mineral fertilizers with full doses of compost were applied. Therefore, it was concluded from Khan et al.'s (2019) findings that the combination of plant residue compost and inorganic fertilizers significantly improved the yield, and quality of tomato fruit, and sustained soil fertility status.

While inorganic fertilizers have high and readily available nutrients, they suffer from short durations that limit their practical application (Qaswar et al., 2020). Organic fertilizer helps save vegetable production as compared to inorganic fertilizer (Al-Munsur et al., 2019), and has more competitive advantages due to their higher organic contents and richer nutrient elements (Ning et al., 2017). Compost application efficiently can mitigate salt stress in tomato plants with respect to inorganic fertilization, and this alleviating role was associated with the induction of a more efficient metabolic response that increased the accumulation of metabolites involved in modulating the salinity stress (Savy et al., 2022). However, Heeb et al.'s (2006) findings showed that yields of red tomatoes from the organically fertilized plants were significantly lower (1.3–1.8 kg plant–1) than yields from plants that received inorganic fertilizer (2.2–2.8 kg plant–1). At the final harvest, yields of green tomatoes in the organic treatment with extra sulfur were similar (1.1–1.2 kg plant–1) to the NOequation image-dominated treatments at both nutrient levels and the NHequation image-dominated treatment at high nutrient levels. According to the authors, organic fertilizers released nutrients more slowly than inorganic fertilizers, resulting in decreased S and P concentrations in the leaves, which limited growth and yield in the orgN treatments. Sugar contents were higher in the fruits given inorganic fertilizer, whereas acid contents were higher in the fruits given organic fertilizer. Heeb et al.'s (2006) findings showed a preference in taste was given to the tomatoes from plants fertilized with the nitrate-dominated nutrient solution and to those given organic fertilizer with extra sulfur. Thus, a reduction in growth, which was expected to lead to a higher concentration of compounds like sugars and acids, did not result in better taste. Overall, it can be concluded that an appropriate nutrient supply is crucial to reach high yields and good taste. These results are somehow supported by the findings of (Bilalis et al., 2018), the highest tomato fruit number per plant (98.5), average fruit weight (63.6 g), and fruit yield (168.0 t ha^{-1}) were obtained under inorganic fertilization. However, the highest total soluble solids (4.39 °Brix) and total soluble solids to titratable acidity ratio (17.4), L* (43.4) and a* (35.4) values, as well as the highest lycopene content (88.5 mg kg-1 f.w). were achieved through the application of organic fertilizer. A significantly higher total soluble solids and total soluble solids to titratable acidity ratio in organically grown tomatoes are particularly important to the processing tomato industry. Finally, the highest lycopene content was produced under organic fertilization as well and the non-significant difference between the organic and conventional tomatoes in terms of lycopene yield makes organic processing tomatoes suitable for lycopene production. It was reported, however, that long-term singular and excessive application of either organic or inorganic fertilizer may damage soil quality, such as the deterioration of soil physicochemical properties, the imbalance of microbial structure, the decrease of soil enzyme activities, and soil heavy metal pollution, thus lowering the yield and quality of crops (Li et al., 2017; Li et al., 2014; Zhu et al., 2019). Thus, the combined application of organic and inorganic fertilizers has become a priority issue in alleviating soil deterioration (Huang et al., 2020; Zhao, et al., 2016). Studies have confirmed that combining organic and inorganic fertilizers has the advantages of both short and long-term effects, which can supply balanced nutrients in the crop growth period, improve soil quality, mitigate farmland pollution, and benefit crop yields (Qaswar et al., 2020); Ali Shah eta l., 2021; Wu et al., 2017). Furthermore, the function and structure of soil microbial communities are also influenced by fertilization (Li et L., 2014). According to Zhao et al. (20140, inorganic nitrogen (N) fertilization is reported to alter soil fungal abundance and fungi/bacteria ratio in wheat and maize fields, while Wu et al. (2017) reported that the populations of some soil bacterial taxa like Kaistobacter and Koribacter were increased by inorganic phosphate (P) fertilizer. Inorganic N fertilizer is the most demanded one across the world (Liu et al., 2021a) because N is widely accepted as the key limiting factor for crop growth and the most active nutrient element in soils (Li et al., 2021b). Finally, it was suggested in a study by Wu et al. (2022) that the combined use of organic-inorganic fertilizers, instead of sole organic or inorganic fertilizer, could significantly improve the yield and quality of tomatoes by ameliorating rhizosphere physicochemical properties, N cycle, and enzyme activities. Organic fertilizer could neutralize soil pH, maintain AP level, and significantly increase soil C (SOC and HU) and N (TN, SON, AN, NH4–N and NO3–N) from primary fruiting to end-fruiting period, while inorganic fertilizer provided sufficient and readily available nutrients for tomato from seedling to flowering period.

Based on the results of the current study, it is therefore recommended that Prime MNF 15-5-20 be registered as a granular fertilizer for tomato production to increase yield and replace a significant amount of granular fertilizer requirement. Consequently, it would also supply several micronutrients necessary for the growth and development of tomato plants.

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