

## **Annexure A**

**Experiment:** To study the effect of Sulphur and Different Manganese salts in water dispersible granular composition (WDG) and Liquid Suspension composition (SC) in varying concentrations on Wheat crop

### **Field experiment methodology:**

The trial was laid out during the Rabi season in Randomized Block Design (RBD) with thirteen treatments including untreated control, replicated four times. For each treatment, plot size of 40 sq. m (8m x 5m) was maintained. The trials were carried out with Sulphur and Manganese salts applied alone, as well as in combination, in different formulations and at varying concentrations, applied as basal application, at the time of sowing of the wheat crop. The wheat crop in the trial field was raised followed good agricultural practices. The seed of Wheat, variety PBW 343, were used for the study and planted in 30 cm, row to row and 10 cm, plant to plant spacing.

### **Details of experiment**

|                          |                           |
|--------------------------|---------------------------|
| a) Trial Location        | : Nasik, Maharashtra      |
| b) Crop                  | : Wheat (var: PBW 343)    |
| c) Experiment season     | : Rabi 2018-19            |
| d) Trial Design          | : Randomized Block Design |
| e) Replications          | : Four                    |
| f) Treatment             | : Thirteen                |
| g) Plot size             | : 8m x 5m = 40 sq. m      |
| h) Date of Application   | : 08.11.2011              |
| i) Date of sowing        | : 08.11.2018              |
| j) Method of application | : Basal                   |
| k) Date of Harvesting    | :06.04.2019               |

The observations on the wheat grain yield was recorded at the harvest time and mean data was presented in Table 1 & Table 2, to enumerate the impact of the combination of Sulphur and Manganese salts, applied alone as well as in combination, in different formulations at varying concentrations on wheat yield.

**Table 1:** To study the effect of Sulphur and Different Manganese salts in water dispersible granular composition (WDG) on Wheat crop

| Treatment Details                                                                                                 | Dose of nutrient salt in g/acre |           | Actual Grain Yield (kg/acre) | % Yield increase over untreated | Expected % Yield increase |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------|-----------|------------------------------|---------------------------------|---------------------------|
|                                                                                                                   | Sulphur                         | Manganese |                              |                                 |                           |
| T1- 15% Manganese (II) Sulfate (Mn-5.46%) SC                                                                      | 0                               | 218.30    | 1850.5                       | 5.74                            |                           |
| T2- Sulphur 90% WDG                                                                                               | 3000                            | -         | 2008.00                      | 14.74                           |                           |
| T3- Sulphur 75% + Manganese (II) Sulfate- 15 % (Mn-5.46%) WDG according to an embodiment of the present invention | 3000                            | 218.30    | 2378.8                       | 35.93                           | 19.64 (1.83*)             |
| T4- 25% Manganese (II) Fumarate (Mn-8.13%) WDG                                                                    | -                               | 541.79    | 1890.3                       | 8.02                            |                           |
| T5- Sulphur 45% + Manganese (II) Fumarate 25% (Mn-8.13%) WDG according to an embodiment of the present invention  | 3000                            | 541.79    | 2469.1                       | 41.09                           | 21.58 (1.90)*             |
| T6-Untreated                                                                                                      | -                               | 230.58    | 1750.00                      | -                               |                           |

\*Synergy factor

“Synergy” is as defined by Colby S. R. in an article entitled “*Calculation of the synergistic and antagonistic responses of herbicide combinations*” published in Weeds, 1967, 15, p. 20-22. The action expected for a given combination of two active components can be calculated as follows:

$$E = X + Y - (XY)/100$$

Where,

E= Expected % effect by mixture of two products X and Y in a defined dose.

X= Observed % effect by product A

Y= Observed % effect by product B

The synergy factor (SF) is calculated by Abbott's formula (Eq. (2) (Abbott, 1925).

$SF = \text{Observed effect} / \text{Expected effect}$

Where,  $SF > 1$  for Synergistic reaction;  $SF < 1$  for antagonistic reaction;  $SF = 1$  for additive reaction.

When the percentage of yield effect observed (E) for the combination is greater than the expected percentage, synergistic effect of the combination can be inferred. When the percentage of yield effect observed for the combination is equal to the expected percentage, merely an additive effect may be inferred, and wherein the percentage of yield effect observed for the combination is lower than the expected percentage, an antagonistic effect of the combinations can be inferred.

It can be observed that the synergy factor is 1.83 and 1.90 for treatments T3 and T5 as seen from Table 1 which depicts that the WDG compositions of "Sulphur + Manganese (II) Sulfate" and "Sulphur + Manganese (II) Fumarate" respectively are synergistic in nature as compared to standalone treatments T1, T2, T4 and treatment T6 (untreated). This synergistic nature of the Treatments T3 & T5 in the form of WDG as per the embodiment of the present invention can be observed from the wheat grain yield.

It was observed from the table 1 that Treatments T3 and T5 with different Manganese salts in varying concentrations in the water dispersible granular form as per the embodiment of the present invention showed an increase of 35.93%, 41.09% respectively in the wheat grain yield as compared to the untreated plants. For instance, Treatment T5 (Sulphur 45% + Manganese (II) Fumarate 25% (Mn-8.13%) WDG) and standalone Treatments T4 (25% Manganese (II) Fumarate (Mn-8.13%) WDG) and T2 (Sulphur 90% WDG) were applied at the same active dosage i. e. 3000g/acre of Sulphur and 541.79 g/acre of Manganese. However, Treatment T5 exhibits grain yield of about 2469.1 kg/acre when compared to stand alone treatments i.e. Treatment T4 with yield of 1890.3 kg/acre and Treatment T2 with yield of 2008 kg/acre. Similarly, higher yield was observed with treatment T3 prepared as per the embodiment of the present invention as compared to treatments T1 and T2.

Thus, the combination of Elemental Sulphur and Manganese Salt in WDG form as per the embodiment of the present invention is synergistic and provides higher grain yield as compared to individual components.

**Table 2:** To study the effect of Sulphur and Different Manganese salts in liquid suspension composition (SC) on Wheat crop

| Treatment details                                                                                               | Dose of nutrient salt in g/acre |           | Actual Grain Yield (kg/acre) | % yield increase over untreated | Expected % yield increase |
|-----------------------------------------------------------------------------------------------------------------|---------------------------------|-----------|------------------------------|---------------------------------|---------------------------|
|                                                                                                                 | Sulphur                         | Manganese |                              |                                 |                           |
| T1- 40% Manganese (II) Oxalate (Mn-15.37%) SC                                                                   | -                               | 768.61    | 1900.6                       | 8.61                            |                           |
| T2- Sulphur 55% SC                                                                                              | 1000                            | -         | 1929.40                      | 10.25                           |                           |
| T3- Sulphur 20% + Manganese (II) Oxalate-40% (Mn-15.37%) SC according to an embodiment of the present invention | 1000                            | 768.61    | 2200.7                       | 25.8                            | 17.97 (1.43*)             |
| T4- 5% Manganese (II) Carbonate (Mn-2.39%) SC                                                                   | -                               | 99.58     | 1770.40                      | 1.17                            |                           |
| T5- Sulphur 55% SC                                                                                              | 2500                            |           | 1966.80                      | 12.39                           |                           |
| T6- Sulphur 60% + Manganese (II) Carbonate 5% (Mn-2.39%) SC according to an embodiment of the present invention | 2500                            | 99.58     | 2265.65                      | 29.47                           | 13.41 (2.20)*             |
| T7-Untreated                                                                                                    | -                               |           | 1750.00                      |                                 |                           |

It can be observed from Table 2 that the synergy factor is 1.43 and 2.20 for treatments T3 and T6 as seen from Table 2 which depicts that the SC compositions of “Sulphur + Manganese (II) Oxalate” and “Sulphur + Manganese (II) Carbonate” respectively are synergistic in nature as compared to standalone treatments T1, T2, T4, T5 and treatment T6 (untreated). This

synergistic nature of the Treatments T3 & T6 in the form of SC as per the embodiment of the present invention can be observed from the wheat grain yield.

It was observed from the table 2 that Treatments T3 and T6 with different Manganese salts in varying concentrations in the suspension concentrate form as per the embodiment of the present invention showed an increase of 25.8%, 29.47% respectively in the wheat grain yield as compared to the untreated plants. For instance, Treatment T6 (Sulphur 60% + Manganese (II) Carbonate 5% (Mn-2.39%) SC) and standalone Treatments T4 (5% Manganese (II) Carbonate (Mn-2.39%) SC) and T5 (Sulphur 55% SC) were applied at the same active dosage i. e. 2500g/acre of Sulphur and 99.58 g/acre of Manganese. However, Treatment T6 exhibits grain yield of about 2265.65 kg/acre when compared to stand alone treatments i.e. Treatment T4 with yield of 1770.40 kg/acre and Treatment T5 with yield of 1966.80 kg/acre. Similarly, higher yield was observed with treatment T3 prepared as per the embodiment of the present invention as compared to treatments T1 and T2.

Thus, the combination of Elemental Sulphur and Manganese Salt in SC form as per the embodiment of the present invention is synergistic and provides higher grain yield as compared to individual components.