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# EFFECT OF BIOFERTILIZERS AND NPK ON YIELD OF GARLIC AND NUTRIENT AVAILABILITY OF SOIL

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## ABSTRACT

**The present investigation entitled "Effect of Biofertilizers and NPK on yield of garlic and nutrient availabilty of soil" was conducted during 2016-17 at the experimental farm Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab, India. The experiment was laid out in a Randomized block design with three replications and nine treatments. The treatments consisted of T1 (Control), T2 (100% RDF), T3 (80% RDF), T4 (60% RDF), T5 (40% RDF), T6 (100% RDF + Azotobacter @5kg/ha + PSB @5kg/ha), T7 (80% RDF + Azotobacter @5kg/ha + PSB @5kg/ha), T8 (60% RDF + Azotobacter @5kg/ha + PSB @5kg/ha) and T9 (40% RDF + Azotobacter @5kg/ha + PSB @5kg/ha). Effect of Biofertilizers and NPK on yield of garlic and nutrient content of soil. Quantitative attributes like yield (147.08 q ha-1) and yield attributes were recorded maximum under T6 treatment. Besides, maximum soil pH (7.53) was noted under control. Regarding soil nutrient availability, maximum available N (200.32 kg ha-1), P (31.94 kg ha-1) and K (119.43 kg ha-1) in soil after harvesting was found in T6 treatment. Looking to economics of various treatments, maximum net return (Rs 3,01,940.00) and B:C ratio (2.17:1) was obtained from T6 treatment. Whereas, minimum B:C ratio (1.14:1) was recorded under control. These results suggested that the optimum production of garlic can be obtained with combined application of 100% NPK and biofertilizers (Azotobacter @5kg/ha + PSB @5kg/ha).**

Keywords: **NPK, Yield, biofertilizer, treatments, Nutrient.**

Vegetables are important in human diet as protective food. India is leading vegetable producing country in the world but the current per capita consumption of vegetable in our country is only 145g as against 300g of vegetable required per day per adult for maintaining good health (Singh *et al.*, 2017). Garlic is one of the most important bulb crop after onion in India and its belongs to family Alliaceae. The bulb of garlic is of a compound nature, consisting of numerous bulb lets, so-called cloves, of different size, the whole surrounded by layers of white scale leaves. Garlic is used as a seasoning in many foods worldwide; without garlic, many of our popular dishes would lack the flavor and character that make them favorites. Its volatile oil has many sulphur containing compounds that are responsible for the strong odor, its distinctive flavor and pungency as well as for its healthful benefits (Salomon, 2002). Garlic has some antifungal, antimicrobial, insecticidal and other medicinal properties. It has hypoglycemic (capable of lowering blood sugar) properties. Garlic therapy has also been suggested in flatulence, constipation, faulty digestion, inadequate food intake, chronic coughs, leprosy and many other diseases (Adegoke *et al.*, 1998). In India garlic is grown an area of 2,74, 000 hectares with a production of 12,71, 000 MT (NHB, 2017). Bio-fertilizer are naturally occurring products with living microorganisms which are resulted from the roots or cultivated soil and don't have any ill effect on plant, soil health and environment. Besides their role in fixing atmospheric nitrogen and phosphorous solubilisation; these are also helpful in stimulating the plant growth hormones. Bio-fertilizer viz.

*Azotobacter*, PSB and *Azospirillum* fix atmospheric nitrogen and solubilise phosphorous to increase fertility of soil and its biological activities. Bio-fertilizers are products containing living cells of different types of microorganism, which have an ability to convert nutritionally important elements and also, bio-fertilizers are known to play an important role in increasing availability of nitrogen and phosphorus besides improving biological fixation of atmospheric nitrogen and produce hormones and anti-metabolites (Bhat *et al.*, 2013). Availability of nitrogen is important for growing plants. It is a main constituent of protein and nucleic acid molecules. It is also a part of chlorophyll molecules. Phosphorus is indispensible constituent of nucleic acids, phospholipids and several enzymes. It is also needed for the transfer of energy within the plant system and is involved in its various metabolic activities. Phosphorus has its beneficial effect on early root development, plant growth, yield and quality (Verma, 1993). Potassium plays a vital role in plant metabolism such as photosynthesis, translocation of photosynthates, regulation of plant pores, activation of plant catalyst and resistance against pests and diseases. Potassium improves colour, glossiness and dry matter accumulation besides improving keeping quality of the crop (Dorais *et al.*, 2001). Therefore, keeping in view the above facts in mind, an attempt has been made in the present investigation to study the effect of Biofertilizers and NPK on yield of garlic and nutrient availability of soil.

## Materials and methods

The field experiment entitled to study the "Effect of Biofertilizers and NPK on yield of garlic and nutrient availability of soil" was carried out at the Experimental Farm, Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, during Rabi season, 2016-17. The crop was planted in a plot size (2m × 2m) at a spacing of 15 cm × 10 cm. Before fertilizer application, random soil samples were taken from the experimental field and were analysed. The experimental field soil is sandy loam with alkaline pH 7.5, available nitrogen (165.20kg/ha), available phosphorus (22.44 kg/ha), and available potassium (120.86 kg/ha).The experiment was laid out in randomized block design with three replications comprising of nine treatments viz., $T_1$ (Control), $T_2$ (100%RDF), $T_3$ (80%RDF), $T_4$ (60%RDF), $T_5$ (40%RDF), $T_6$ (100%RDF + *Azotobacter* @5kg/ha + PSB @5kg/ha), $T_7$ (80%RDF + *Azotobacter* @5kg/ha + PSB @5kg/ha), $T_8$ (60%RDF + *Azotobacter* @5kg/ha + PSB @5kg/ha) and $T_9$ (40%RDF + *Azotobacter* @5kg/ha + PSB @5kg/ha). Observations were recorded on randomly ten selected plants with different characters *i.e.* bulb diameter (cm), **dry weight of bulb (g), number of cloves per bulb,** bulb yield (kg per plot), bulb yield (q per hectare), nutrient availability (kg per ha) of soil and economics of treatment.

## RESULTS AND DISCUSSIONS

### Quantitative attributes

### Bulb (Equatorial and polar) diameter (cm)

Bulb diameter (cm) was significantly influenced by various treatments presented in Table 1. Bulb size is directly correlated with yield and is a character which appeals to the consumers. Large sized bulbs yield more and consumer also prefers large to medium sized bulbs. Maximum equatorial (5.45 cm) and polar diameters (4.64 cm) of bulb were recorded in the treatment **$T_6$ (100 % RDF + *Azotobacter* + PSB)** and minimum equatorial (3.21 cm) and polar diameters (3.15 cm) of bulb were observed in $T_1$ (control). This may be due to combined application of bio-fertilizers with inorganic fertilizers which attributed to the fact that bio-fertilizers are known to synthesize the growth promoting substances besides increasing the availability of atmospheric nitrogen and soil phosphorus which might have led to luxuriant bulb size. The related findings were also reported by Bhandari *et al.* (2012) and Yogita *et al.* (2012).

**Bulb weight (g)**

Weight of bulb (g) was significantly influenced by various treatments presented in Table 1. Average bulb weight (22.06 cm) was maximum in the plants receiving from treatment $T_6$ (100 % RDF + *Azotobacter* + PSB) which was followed by **$T_7$ (80 % RDF + *Azotobacter* + PSB)** and minimum bulb weight (13.77 cm) were observed in treatment $T_1$ (control). The increase in the bulb weight could be due to the increased uptake of nutrients and build up of sufficient photosynthates enabling the increase in size of bulbs (length and breadth), ultimately resulting in the increased average bulb weight. These results are in confirmation with the findings of Yogita *et al.* (2012).

**Number of cloves per bulb**

Table 1 revealed significant effects on number of cloves per bulb. Maximum number of cloves per bulb (26.09) were reported in $T_6$ (100 % RDF + *Azotobacter* + PSB) followed by **$T_7$ (80 % RDF + *Azotobacter* + PSB), $T_2$** (100% RDF)**, $T_3$** (80% RDF) **and $T_8$ (60 % RDF + *Azotobacter* + PSB)** whereas under control, minimum number of cloves per bulb (18.45) were observed under treatment $T_1$ (control). This may be due to the fact that phosphorus with nitrogen enhances root initiation and its development that improves better utilization of moisture and food material. Translocation of these food materials during the bulb formation and development resulted into more number of cloves per bulb. The related findings were also reported by Kore *et al.* (2006) and Bhandari *et al.* (2012).

**Bulb yield (kg/plot, kg/ha)**

The main and important objective of any production programme is to have maximum crop yield for better returns. Data regarding bulb yield per plot (kg) and per hectare (q) reveals a significant difference among different treatments in Table 2. The maximum bulb yield per plot (5.88 kg) and per hectare (147.08 q) was recorded in $T_6$ (100 % RDF + *Azotobacter* + PSB) which was statistically at par with $T_7$ (80 % RDF + *Azotobacter* + PSB) and minimum was noticed in $T_1$ (control). This increase is due to more number of cloves per bulb, better bulb size and high average weight of bulbs. Use of *Azotobacter* and PSB not only makes the atmospheric nitrogen and soil phosphorus available to plants but also enhances the plant growth and bulb yield due to release of hormone and nutrients. Similar results were also reported by Gaiki *et al.* (2006), Kore *et al.* (2006), Gowda *et al.* (2007), Talware *et al.* (2012), Damse *et al.* (2014) Das *et al.* (2014) and Singh *et al.* (2017).

**Nutrient availability of soil (kg $ha^{-1}$)**

The data pertaining to available N content in soil was significantly influenced by different treatment combinations in Table 3. The available N content in soil (200.32 kg $ha^{-1}$) was maximum in $T_6$ (100 % RDF + *Azotobacter* + PSB), whereas minimum (161.30 kg $ha^{-1}$) was recorded in $T_1$ (control). This may be due to the application of bio-fertilizer (*Azotobacter*) with NPK that resulted into higher accumulation of N in the soil. Available nitrogen can be increased by the addition of nitrogenous fertilizers. The present results get the support from the work of Nainwal *et al.* 2015. Available P content in soil (31.94 kg $ha^{-1}$) was maximum in $T_6$ (100 % RDF + *Azotobacter* + PSB) which was statistically at par with **$T_7$ (80 % RDF + *Azotobacter* + PSB)** and **$T_2$** (100% RDF), however, minimum was recorded in $T_1$ (control). The increase in the availability of P may be partly attributed to the activity of certain microbes present in bio-fertilizers (PSB) releasing organic acids which are responsible for conversion of unavailable P to available P. The results are in agreement with the findings reported by Singh *et al.* (2008) and Sharma *et al.* (2009). The effect of different treatments was not significant of available K in soil. Maximum available (119.43 kg $ha^{-1}$) and minimum available (113.27 kg $ha^{-1}$) potassium in soil was found. Similar findings were reported by Singh *et al.* (2008) and Sharma *et al.* (2009).

## Economics

Data on economics of various treatments were presented in Table 3 revealed that the plot treated with 100 % RDF + *Azotobacter* + PSB treatment ($T_6$) gave maximum net returns of Rs 301940 per hectare. Maximum benefit: cost ratio (2.17:1) was also observed in treatment $T_6$ (100 % RDF + *Azotobacter* + PSB) while minimum (1.14:1) was recorded under control.

## Conclusion

From the finding of present investigation, it is concluded 100 % RDF + *Azotobacter* + PSB have significantly influenced the yield of crop and nutrient availability of soil. On the basis of results summarized above, it can be concluded that application of 100% NPK and biofertilizers gave the best result. The lowest net income overall was in control treatment. Thus it can be said that for obtaining maximum yield as well as profit from garlic proper application of Nitrogen, Phosphorus and Potassium and biofertilizers should be applied as optimum nutrition is the key to achieve maximum crop production.

**Table 1: Effect of bio-fertilizers and NPK on yield attributes of garlic crop**

| TREATMENTS | | Equatorial diameter (cm) | Polar diameter (cm) | Bulb weight (g) | Number of cloves per bulb |
|---|---|---|---|---|---|
| $T_1$ | Control | 3.21 | 3.15 | 13.77 | 18.45 |
| $T_2$ | 100% RDF (NPK) | 4.70 | 4.28 | 20.65 | 25.15 |
| $T_3$ | 80% RDF | 4.66 | 4.19 | 20.22 | 24.86 |
| $T_4$ | 60% RDF | 3.75 | 3.52 | 18.00 | 23.41 |
| $T_5$ | 40% RDF | 3.58 | 3.37 | 16.20 | 21.29 |
| $T_6$ | 100% RDF + *Azotobacter* + PSB | 5.45 | 4.64 | 22.06 | 26.09 |
| $T_7$ | 80% RDF + *Azotobacter* + PSB | 5.27 | 4.31 | 21.60 | 25.97 |
| $T_8$ | 60% RDF + *Azotobacter* + PSB | 4.37 | 3.72 | 19.87 | 24.78 |
| $T_9$ | 40% RDF + *Azotobacter* + PSB | 4.29 | 3.62 | 19.23 | 24.41 |
| **SEm (±)** | | 0.10 | 0.13 | 0.36 | 0.44 |
| **CD (P=0.05)** | | 0.30 | 0.39 | 1.09 | 0.31 |

**Table 2: Effect of bio-fertilizers and different level of NPK on yield attributes of garlic crop**

| | TREATMENTS | Bulb yield per plot (kg) | Bulb yield per hectare (q) | Available nitrogen content in soil (kg ha$^{-1}$) | Available phosphorus content in soil (kg ha$^{-1}$) | Available potassium content in soil (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|
| $T_1$ | Control | 3.67 | 161.30 | 20.07 | 114.96 | 114.96 |
| $T_2$ | 100% RDF (NPK) | 5.50 | 196.45 | 29.85 | 116.13 | 116.13 |
| $T_3$ | 80% RDF | 5.39 | 187.08 | 27.21 | 113.27 | 113.27 |
| $T_4$ | 60% RDF | 4.80 | 173.95 | 24.14 | 117.17 | 117.17 |
| $T_5$ | 40% RDF | 4.32 | 171.75 | 23.44 | 114.50 | 114.50 |
| $T_6$ | 100% RDF + *Azotobacter* + PSB | 5.88 | 200.32 | 31.94 | 119.43 | 119.43 |
| $T_7$ | 80% RDF + *Azotobacter* + PSB | 5.76 | 198.19 | 30.89 | 118.10 | 118.10 |
| $T_8$ | 60% RDF + *Azotobacter* + PSB | 5.30 | 182.26 | 26.01 | 118.83 | 118.83 |
| $T_9$ | 40% RDF + *Azotobacter* + PSB | 5.13 | 177.92 | 25.15 | 116.20 | 116.20 |
| **SEm (±)** | | 0.10 | 2.42 | 1.32 | 0.73 | 1.84 |
| **CD (P=0.05)** | | 0.29 | 7.25 | 3.96 | 2.18 | NS |

**Table 3: Effect of bio-fertilizers and NPK on economics of garlic crop**

| | TREATMENTS | Gross income (Rs ha$^{-1}$) | Cost of cultivation (Rs ha$^{-1}$) | Net return (Rs ha$^{-1}$) | B:C Ratio |
|---|---|---|---|---|---|
| $T_1$ | Control | 275490 | 128550 | 146940 | 1.14 |
| $T_2$ | 100 % RDF (NPK) | 412740 | 136550 | 276190 | 2.02 |
| $T_3$ | 80 % RDF | 404490 | 134950 | 269540 | 2.00 |
| $T_4$ | 60 % RDF | 359760 | 133350 | 226410 | 1.70 |
| $T_5$ | 40 % RDF | 324000 | 131750 | 192250 | 1.46 |
| $T_6$ | 100 % RDF + *Azotobacter* + PSB | 441240 | 139300 | 301940 | 2.17 |
| $T_7$ | 80 % RDF + *Azotobacter* + PSB | 431760 | 137700 | 294060 | 2.14 |
| $T_8$ | 60 % RDF + *Azotobacter* + PSB | 397500 | 136100 | 261400 | 1.92 |
| $T_9$ | 40 % RDF + *Azotobacter* + PSB | 384750 | 134500 | 250250 | 1.86 |

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