EFFECT OF NPK AND SULPHUR ON YIELD, YIELD ATTRIBUTES AND ECONOMICS OF CAULIFLOWER (BRASSICA OLERACEA VAR. BOTRYTIS L.) VARIETY PUSA SYNTHETIC

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ABSTRACT

A field experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during Rabi season 2015-16. The experiment consisting four levels of NPK (0, 75, 100 and 125% RD of NPK) and four doses of sulphur (0, 20, 40 and 60 kg sulphur ha\(^{-1}\)) with total 16 treatment combinations were tested in randomized block design with three replications. Results revealed that application of 125 per cent recommended dose of NPK and sulphur doses @ 60 kg ha\(^{-1}\) to the cauliflower crop significantly increased the average weight of curd (g), total curd yield (kg plot\(^{-1}\) and q ha\(^{-1}\)), volume of curd (ICC), net returns (Rs) and B:C ratio as compared to control, 75 per cent recommended dose of NPK and 20 kg sulphur ha\(^{-1}\) but statistically at par with 100 per cent recommended dose of NPK with 40 kg sulphur ha\(^{-1}\). The combined application of 100 per cent recommended dose of NPK with 40 kg sulphur ha\(^{-1}\) proved to be most superior treatment combination in terms of average weight of curd (g), total yield of curd per plot (kg), total curd yield (q ha\(^{-1}\)) net returns and B:C ratio because resulting saving of 25 per cent recommended dose of NPK and 20 kg sulphur ha\(^{-1}\).

INTRODUCTION

Cauliflower (Brassica oleracea var. botrytis L.) is the most popular vegetable crop among cole crops belong to the family Cruciferae. It is being grown round the year for its white and tender curd. In India, two separate groups of cauliflower are commonly grown viz. Indian or tropical types (originated in India) and the annual temperate or European type also known as ‘Erfurt’ or snowball type. The Indian types form curds at 20 to 25 °C and the temperate types require a temperature of 10 to 16 °C for curd formation. The Indian types are resistant to water logging and heat. The typical Indian or Tropical cauliflowers have been developed from the inter-crossing of Cornish type (biennial) with European strains. Tropical types have more variability and strong self-incompatibility. Temperate types have less variability and less or no self-incompatibility. Tropical types do not require of vernalization but requires cold treatment at 10 to 13 °C for 6 weeks. Temperate types require vernalization at 7 °C for 8-10 weeks. It has small thick stem, bearing whorl of leaves and branched tap root system. The main point develops into shortened shoot system whose apices make up the convex surface of curd. It is used as fried vegetable, dried vegetable, making soup and pickles. In Rajasthan, Cauliflower is grown extensively in the district of Ajmer, Alwar, Tonk, Sikar, Bundi, Bharatpur, Nagaur, Rajasthan, Ganganagar, Jaipur and Jodhpur.

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Total area of cauliflower in Rajasthan is about 9.42 thousand ha with an annual production of about 36.61 thousand tonnes and productivity about 3.89 MT (Anonymous, 2013). Among various essential plant nutrients, nitrogen is an essential for plant growth, development and reproduction. Nitrogen is associated with vigorous vegetative growth. It is helpful in large size compact curd development. The proper use of nitrogen improves the curd size, nutrient value and reduces the chances of buttoning (Markovic and Diurovaka, 1990). Phosphorus is a constituent of nucleic acid, phytin and phosphorus. So, an adequate supply of phosphorus in early stage of plant life is an important in laying down the primordia for the reproductive parts of the cauliflower. It is also an essential constituent of majority of enzymes which are of great important in the transformation of energy in carbohydrate and fat metabolism and also in respiration in plants (Yawalkar et al., 1996). Potassium imparts increased vigour and disease resistance to plant. It also regulates water conduction within the plant cell and water loss from the plant by maintaining the balance between anabolism, respiration and transpiration. Thus reduces tendency to wilt and help in better utilization of available water which ultimately help in the formation of protein and chlorophyll and quality (Rutkauskiene and Poderys, 1999). Sulphur is an essential plant nutrient and it stands next to primary nutrients in importance. Sulphur plays a vital role in biosynthesis of certain amino acids (cysteine, cystine and methionine) that are essential component of protein and also help in the synthesis...
of coenzyme-A and formation of chlorophyll and nitrogenase enzyme. Further, sulphur also provides winter hardiness and drought tolerance, control of insect pests and disease etc. Two natural growth regulators, thiamin and biotin contain sulphur. Sulphur occurs in glutathione that is important in oxidation reduction reaction (Kanwar, 1976). It is one of the constituents of vitamin B₈, some volatile oils and amino acids like methinine (21% S). It is involved in various metabolic and enzymatic processes in the plant (Goswami, 1988). The substantial decrease in SO₂ emission to less than 10 kg ha⁻¹ of S further intensified S deficiency in plants, because as much as 30 per cent of its total amount can be absorbed from SO₂ in the air. The S cycle and its effect on plants are often compared to N (oxidation in soil and reduction in plants). The main difference is that S from organic compounds can be re-oxidised to SO₄²⁻ in plants (Vanek et al., 2001).

**MATERIAL AND METHODS**

**Specific climatic condition**

The field experiment was conducted at Horticulture farm, S.K.N. College of Agriculture, Jobner, Jaipur during Rabi season 2015-16 during October to January. The climate of Jobner is typically semi-arid characterized by extremes of temperature both in summer and winter, low rainfall and moderate relative humidity. The mean daily temperature and minimum during the growing season of cauliflower fluctuated 37.2°C and 2.1°C, relative humidity ranged from 41 to 67 per cent. The mean value of evaporation from USWB class pan ranged from 1.9 to 5.9 mm. There was a total rainfall of 10.0 mm in Rabi season as against the average rainfall 400 mm. The soil was loamy sand in texture, slightly alkaline in reaction, poor in organic carbon with low available nitrogen, phosphorus and medium in potassium content.

**Seed material and preparation of nursery bed**

Two raised nursery beds of dimensions of 3 m x 1 m x 0.15 m (Length x Width x Height) were prepared by mixing well rotten FYM in soil @ 15 kg/m². Seeds of cauliflower cv. Pusa Synthetic obtained from National Seed Corporation and treated with 0.02 per cent Thiram to save the seedlings from damping off disease. A thin layer of powered leaf mould was used to cover the seeds. Regular watering was done. The seedlings were ready for transplanting in 4-5 weeks.

**Experimental design and treatment application**

The experiment was comprised of 16 treatment combinations carried out in Randomized Block Design (RBD) with four levels of NPK (control, 75, 100 and 125 % RD of NPK) denoted by F₀, F₁, F₂ and F₃ and Sulphur (control, 20, 40 and 60 kg ha⁻¹) denoted by S₀, S₁, S₂ and S₃. The recommended dose of NPK for cauliflower is 120 kg, 80 kg and 80 kg per ha respectively. Full dose of P₂O₅, K₂O and half dose of N in various treatments were applied manually as the basal dose at the time of transplanting. Remaining dose of nitrogen was given as top dressing in two split doses at 30 and 45 days after transplanting. Sulphur was applied as per treatment through agriculture grade elemental sulphur and was broadcasted uniformly before transplanting and incorporated in the soil.

**Economics of treatments**

The economics of the treatments is the most important consideration for making any recommendation to the farmers for its wide adoption. For calculating economics, the average treatment yield along with prevailing market rates of the produce and cost of inputs were used. B: C ratio was computed by dividing gross returns with cost of cultivation for each treatment.

**RESULT AND DISCUSSION**

**Effect of NPKs on yield attributes and yield**

The perusal of data presenting in Table 1 shows that the effect of NPK had significant influence on the average weight and volume of curd. The mean maximum average weight of curd (371.68 g) and volume of curd (264.65 CC) was observed in F₃ i.e. 125 per cent recommended dose of NPK, which was found to be significantly higher over F₀ and F₁ but it was statistically at par with F₂ i.e. 100 per cent recommended dose of NPK, whereas, minimum volume of curd (150.77 CC) was recorded under F₀ treatment. In case of yield data reveals that total curd yield per plot and ha⁻¹ was significantly influenced by various fertility levels. The maximum yield of curd per plot (5.95 kg) and total curd yield ha⁻¹ (183.55 q ha⁻¹) was recorded under 125 per cent recommended dose of NPK (F₃) followed F₂ and F₁. While minimum curd yield per plot and ha⁻¹ (3.42 kg, 105.60 q ha⁻¹) was recorded under control. The maximum yield of curd per plot and ha⁻¹ under the treatment F₁ was found significantly more over to F₀ and F₁ but it was statistically at par with F₂ treatment.

The application of 100 per cent recommended dose of NPK significantly increased the average weight of curd (g), curd yield per plot (kg), curd yield per ha⁻¹ and volume of curd (CC) (Table 2). However 100 per cent recommended dose of NPK (F₂) was statistically at par to 125 per cent recommended dose of NPK (F₃) in all the above characters. This might be due to the fact that increased NPK levels, helped in the expansion of leaf area and chlorophyll content which together might have accelerated the photosynthetic rates and in turn increased the supply of carbohydrates to plants. The application of 100 per cent recommended dose of NPK favoured the metabolic and auxin activities in plant and ultimately resulted in increasing curds weight, volume of curd finally the total yield. However, potassium does not increase the yield of plant but indirectly supported to yield. These results are also in close conformity with the finding of Batel et al. (1997), Everaast and Bou (2000), Yaldas et al. (2008) and Abd el-All and EL- Shabrawy (2013).

Data (Table 1) Shows that the application of different fertility levels significantly influenced the net return and B:C ratio of...

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**Fig. 1** Effect of NPK and sulphur on average weight of curd and volume of curd

**Effect of NPKs on economics**

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cauliflower. The application of F₁ i.e. 125 per cent recommended dose of NPK significantly recorded maximum net returns (288879) and B:C (3.68) to control and F₁. Though the minimum net returns (140942) and B:C (2.00) was recorded under F₀. The application of 125 per cent recommended dose of NPK (F₁) remained statistically at par with 100 per cent recommended dose of NPK (F₂) in case of net returns.

Table 1 Effect of NPKs on sulphur on yield, yield attributes and economics of cauliflower

| Treatments | Average weight of curd (g) | Volume of curd (cc) | Curd yield (kg/plot) | Curd yield (q/ha) | Net returns (Rs/ha) | B:C ratio |
|------------|---------------------------|---------------------|----------------------|-------------------|---------------------|-----------|
| Fertility levels | | | | | | |
| Control (F₀) | 213.83 | 150.77 | 3.42 | 105.60 | 140942 | 2.00 |
| 75 per cent RD of NPK (F₁) | 286.65 | 211.36 | 4.59 | 141.56 | 208078 | 2.77 |
| 100 per cent RD of NPK (F₂) | 358.73 | 247.35 | 5.74 | 177.15 | 277677 | 3.61 |
| 125 per cent RD of NPK (F₃) | 371.68 | 264.65 | 5.95 | 183.55 | 288879 | 3.68 |
| Sulphur levels (kg/ha) | | | | | | |
| Control (S₀) | 5.62 | 6.98 | 0.09 | 2.74 | 7502 | 0.08 |
| Sulphur 20 kg ha⁻¹ (S₁) | 16.24 | 20.16 | 0.26 | 7.92 | 21665 | 0.24 |
| Sulphur 40 kg ha⁻¹ (S₂) | 214.18 | 147.12 | 3.43 | 105.77 | 137554 | 1.84 |
| Sulphur 60 kg ha⁻¹ (S₃) | 286.28 | 212.52 | 4.58 | 141.37 | 208064 | 2.76 |
| Sulphur 80 kg ha⁻¹ (S₄) | 358.39 | 248.18 | 5.73 | 176.98 | 278583 | 3.66 |
| Sulphur 100 kg ha⁻¹ (S₅) | 372.05 | 266.31 | 5.95 | 183.73 | 291375 | 3.80 |
| Sulphur 125 kg ha⁻¹ (S₆) | 5.62 | 6.98 | 0.09 | 2.74 | 7502 | 0.08 |
| CD at 5% | 16.24 | 20.16 | 0.26 | 7.92 | 21665 | 0.24 |

Effect of sulphur on yield attributes and yield

A perusal of data given in Table 1 reveals that the application of 40 kg S ha⁻¹ significantly increased yield attributes viz., average weight of curd (g), total curd yield per plot (kg), total curd yield per ha (q) and volume of curd (CC) as compared to control and 20 kg sulphur but remained statistically at par with 60 kg sulphur per ha. The maximum average weight of curd (372.05 g) and volume of curd (266.31 CC) was recorded with 60 kg ha⁻¹ whereas minimum was recorded under control. The critical analysis of data also presented in same Table reveals that the different sulphur doses significantly influenced the curd yield per plot and per ha. The maximum curd yield per plot (5.95 kg) and per ha (105.77 q ha⁻¹) was recorded with 60 kg S ha⁻¹, which was statistically at par with 40 kg S ha⁻¹. While minimum was recorded under control.

The increase in yield and yield attributes might be due to the important role of sulphur in lowering the pH of saline-alkaline soil resulting in increased availability of many nutrients (Hossan and Olsen, 1966) or might be the activation of a number of enzymes and also in carbohydrate metabolism (Tandon, 1986) which in turn might have favoured better development of curd and resulted in increased growth and ultimately higher yield. The results are in close conformity with those of Hara et al. (1981), Bijarnia and Dixit (1996), Bhagavatagoudra and Rokhade (2001) and Gautam (2012). The increase in yield attributes was probably due to source and sink relationship. The increase in yield attributes can be attributed to increase the size of source and consequently the enhanced partitioning of photosynthates towards sink. The results revealed that application of 60 kg sulphur ha⁻¹ significantly increased the curd yields ha⁻¹ of cauliflower as compared to control and 20 kg sulphur per ha, which were found statistically at par with 60 kg S ha⁻¹. These finding corroborates with the findings of Dhar et al. (1999), Jamre et al. (2010) and Talukder et al. (2013).

While minimum net returns (137554) and B:C ratio (1.84) were recorded in control. The application of 125 per cent recommended dose of NPK and 40 kg sulphur ha⁻¹ resulted maximum net return of Rs. 288879 and 291375 with the benefit cost ratio of 3.68 and 3.80 respectively, which were at par with 100 per cent recommended dose of NPK and 60 kg S ha⁻¹ having net return of Rs. 277677 and 278583 with the benefit cost ratio of 3.61 and 3.66. So the treatment 100 per cent recommended dose of NPK and 40 kg S ha⁻¹ were found to be economically best.

CONCLUSION

On the basis of present investigation, it can be concluded that the combined application of 100 per cent recommended dose of NPK along with sulphur 40 kg ha⁻¹ was found best to harvest a good cauliflower crop with maximum yield (207.56 q/ha), net returns (Rs. 338143 ha⁻¹) and B:C ratio (4.39), respectively because resulting saving of 25 per cent recommended dose of NPK and 20 kg sulphur ha⁻¹. Thus, application of 100 per cent recommended dose of NPK along with sulphur 40 kg ha⁻¹ recommended for cauliflower crop.

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