

Original Research Article

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Response of NPK and Sulphur on Nutrient Analysis and quality attributes of Cauliflower (*Brassica oleracea* var. *botrytis* L.)

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ABSTRACT

Keywords

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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). The 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 nitrogen, phosphorus, potassium and sulphur content in curd and nitrogen, phosphorus, potassium in soil 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 and 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 nutrient analysis 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. It is a fair source of vitamin-A (51 IU), vitamin-C (56 mg), riboflavin (0.10 mg), thiamin (0.04 mg), nicotinic acid (1.0 mg), calcium (33 mg), phosphorus (57 mg), potassium (138 mg), moisture (90.8 g), carbohydrates (4.0 g), protein (2.6 g), fat (0.4 g), fiber (1.2 g), and iron (1.5 mg) per 100 g of edible portion of cauliflower (Fageria *et al.*, 2012). Cauliflower is grown commercially on an area of about 433.9

thousand hectares with an annual production of about 85.73 lakh tonnes and productivity is about 19.8 MT/ha In India, West Bengal have maximum area, production and productivity. 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, 2014).

Nitrogen is an essential plant nutrient, which is involved in physiological processes and enzyme activities. Farmers use urea excessively as a nitrogen fertilizer to enhance

curd initiation and increase curd size in cauliflower. Nitrogen could increase production of cauliflower, but the curd quality is affected. High nitrogen contents with deficits of other nutrients could reduce the storage life of cauliflower and buttoning (Kirthisinghe, 2006). Mineral nutrition does play an important role in influencing the quality of crops and it is fact that the soil health deteriorates due to continuous use of chemical fertilizers (Savci, 2012). Phosphorus is a constituent of nucleic acid, phytin and phosphorus. 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. 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 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. It is one of the constituents of vitamin B₁, 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. After reduction in the plant S participates in various primary and secondary compounds, such as the amino acids cysteine and methionine, vitamins B₁ and H and enzymes and coenzymes (Haneklaus *et al.*, 1997).

Materials and Methods

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 mean daily temperature maximum and minimum during the growing season of cauliflower fluctuated 37.2⁰C and 2.1⁰C, 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.

The experiment was comprised of 16 treatment combinations carried out in Randomized Block Design (RBD) with four levels of NPK (0, 75, 100 and 125 % RD of NPK) denoted by F₀, F₁, F₂ and F₃ and Sulphur (0, 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. Seeds of cauliflower *cv.* Pusa Synthetic obtained from

National Seed Corporation treated with 0.02 per cent *Thiram* to save the seedlings from damping off disease. The seedlings were ready for transplanting in 4-5 weeks.

Total chlorophyll content in leaves (mg/g)

Total chlorophyll content was determined at 40 DAT by using the method of Arnon, 1949. 50 mg fresh leaf material was used for chlorophyll estimation. The materials were homogenized with 5 ml of 80 per cent acetone in a mortar with pestle. Then this aliquot was taken and centrifuged for 10 minutes at 2000 rpm and made the final volume to 10 ml and clear supernatant solution was taken. Absorbance of clear supernatant was measured at 663 nm and 645 nm on Spectronic-20 (spectrophotometer).

$$\text{Total chlorophyll (mg/g)} = \frac{20.5 (A_{645} + 8.02 (A_{663}))}{1000 \times W} \times V$$

Where,

A= Absorbance specific wave lengths

V= Final volume of chlorophyll extract in 80% acetone solution

W= Fresh weight of bits of leaves extracted

Results and Discussion

Effect of NPKs on nutrient analysis

The application of different levels of NPK significantly influenced the NPKs content in curd (Table 2). The mean maximum nitrogen (3.46 %), phosphorus (0.309 %), potassium (2.87 %) and sulphur (1.27 %) content in curd were recorded under 125 per cent recommended dose of NPK (F₃), which was significantly superior to F₀ and F₁ but statistically at par with F₂. Whereas,

minimum nitrogen (2.33 %), phosphorus (0.204 %), potassium (2.10 %) and sulphur (1.00 %) content in curd were observed under control. The application of different levels of NPK also significantly influenced the NPKs content in soil. The mean maximum nitrogen (137.92 kg/ha), phosphorus (18.52 kg ha⁻¹) and potassium (142.53 kg ha⁻¹) in soil were recorded under 125 per cent recommended dose of NPK (F₃), which was significantly superior to F₀ and F₁ but statistically at par with 100 per cent recommended dose of NPK (F₂). Whereas, minimum nitrogen (131.78 kg/ha), phosphorus (16.38 kg ha⁻¹) and potassium (128.71 kg ha⁻¹) content in soil was recorded under control, respectively. The results of present investigation revealed that NPK, Sulphur and chlorophyll content in curd increased significantly with the increasing levels of NPK (Table 2). The content of any nutrient in the plant is directly related to its availability in the feeding zone and the growth of the plant. It is obvious that the application of 100 per cent recommended dose of NPK increased the concentration of NPK in soil and plant. Markovic and Diurovaka (1990) reported that proper nitrogen dose, improve nutritional value of cauliflower and reduces the chances of buttoning. However potassium helps in the formation of protein and chlorophyll and improves the quality of cabbage head in relation to taste and keeping quality. Kumhar (2004), Haque *et al.*, (2006) and Abd el-All and EL- Shabrawy (2013) (Table 1).

Effect of NPKs on quality attributes

Chlorophyll content (Table 2) of cauliflower also significantly influenced by different fertility levels. The maximum chlorophyll content (1.42 mg g⁻¹) was recorded under F₃ (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. The NPK are considered as one of

the major nutrient required for proper growth and development of the plant. Besides this, nitrogen is a main constituent of protoplasm, cell nucleus, amino acids, proteins, chlorophyll and many other metabolic products (Kumhar, 2004). Phosphorus is a constituent of nucleic acid, phytin and phospholipids.

The response to potassium fertilization in terms of overall improvement in growth parameters is further supported by the fact that the leaching losses of potassium were more in light textured soils. Therefore, potassium fertilization improved overall crop growth in terms of plant height, number of leaves per plant and quality attributes viz. chlorophyll content in leaves. Potassium helps in the protein and chlorophyll formation ultimately the NPK are used for better vegetative growth. The results are in close conformity with the finding of Patil *et al.*, (2003), Kumhar (2004), and Abd el-All and EL- Shabrawy (2013).

Effect of sulphur on nutrient analysis

The perusal of data presented in table 2 shows that the NPKs content of curd was influenced by different sulphur doses. The maximum nitrogen (3.47 %), phosphorus (0.311 %),

potassium (2.86 %) and sulphur (1.26 %) content were recorded under the treatment 60 kg S ha⁻¹ (S₃). While, minimum nitrogen (2.33 %), phosphorus (0.202 %), potassium (2.08 %) and sulphur

(1.01 %) content in curd were recorded in control. The treatment S₂ was found significantly superior over control and S₁ but statistically at par with S₃ was recorded. Results in same table also show that the NPKs content in soil was influenced by different sulphur doses. The maximum nitrogen (137.48 kg ha⁻¹), phosphorus (18.61 kg ha⁻¹) and potassium (143.11 kg ha⁻¹) content in soil were recorded under the treatment 60 kg S ha⁻¹ (S₃). While, minimum nitrogen (132.12 kg ha⁻¹), phosphorus (16.25 kg ha⁻¹) and potassium (128.11 kg ha⁻¹) content in soil were in control.

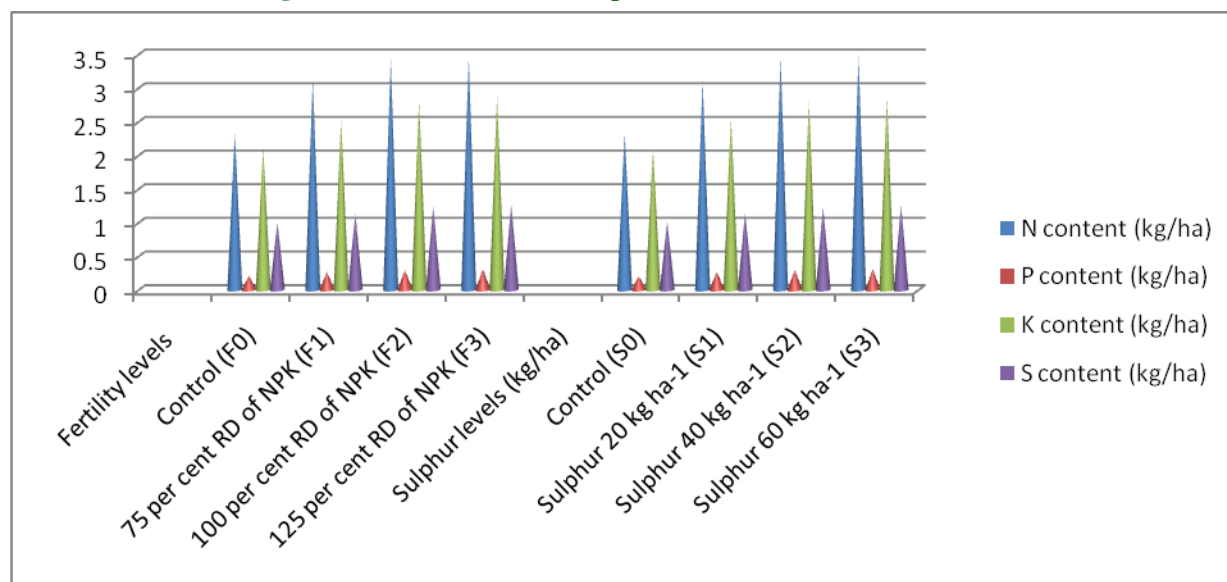
The treatment S₂ was found significantly superior over control and S₁ but statistically at par with S₃. Increased accumulation of nutrients especially N, P and S in vegetative plant parts concomitant with improved metabolism led to greater translocation of these nutrients to reproductive structure of crops. The results are in conformity with the findings of Chhipa (2005) and Abd el-All and EL- Shabrawy (2013).

Table.1 Nutrients analysis with their estimating methods

Nutrient content	Estimating methods
N content in curd (%)	Nessler's reagent in spectrophotometer method (Snell and Snell, 1949).
P content in curd (%)	Spectrophotometer method using Triacid Ammonium Molybdate-Ammonium Vanadate solution (Jackson, 1973).
K content in curd (%)	Flame photometer method including Triacid, Potassium standard solution (Richards, 1954).
Sulphur content in curd (%)	Turbidometric method (Tabutabi and Bermner, 1970).
Available N (kg/ha) in soil	Alkaline permanganate method (Subbiah and Asija, 1956).
Available P ₂ O ₅ (kg/ha) in soil	Olsen's method (Olsen <i>et al.</i> , 1954).
Available K ₂ O (kg/ha) in soil	Flame photometer method (Metson, 1956).

Table.2 Effect of NPK and sulphur on nutrient analysis and quality attributes of Cauliflower

Treatments	N content (kg/ha)	P content (kg/ha)	K content (kg/ha)	S content (kg/ha)	Available N	Available P ₂ O ₅	Available K ₂ O	Chlorophyll content (mg/g)
Fertility levels								
Control (F ₀)	2.33	0.204	2.10	1.00	131.78	16.38	128.71	1.09
75 per cent RD of NPK (F ₁)	3.13	0.266	2.52	1.13	133.23	17.67	135.80	1.26
100 per cent RD of NPK (F ₂)	3.44	0.296	2.80	1.24	136.19	18.49	141.69	1.37
125 per cent RD of NPK (F ₃)	3.46	0.309	2.87	1.27	137.92	18.52	142.53	1.42
SEm_±	0.03	0.005	0.03	0.01	1.23	0.26	2.02	0.04
CD at 5%	0.09	0.014	0.09	0.04	3.54	0.76	5.82	0.11
Sulphur levels (kg/ha)								
Control (S ₀)	2.33	0.202	2.08	1.01	132.12	16.25	128.11	1.05
Sulphur 20 kg ha ⁻¹ (S ₁)	3.11	0.265	2.55	1.14	133.58	17.66	135.45	1.25
Sulphur 40 kg ha ⁻¹ (S ₂)	3.46	0.298	2.79	1.23	135.95	18.55	142.05	1.38
Sulphur 60 kg ha ⁻¹ (S ₃)	3.47	0.311	2.86	1.26	137.48	18.61	143.11	1.46
SEm_±	0.03	0.005	0.03	0.01	1.23	0.26	2.02	0.04
CD at 5%	0.09	0.014	0.09	0.04	3.54	0.76	5.82	0.11

Fig.1 Effect of NPK and sulphur on NPKS content in curd

From the experiment, NPK and sulphur increased significantly with the increasing levels of sulphur (Table 2 and Fig. 1). The results may be due to the fact that nitrogen and sulphur are the main ingredients of protein and increase in their availability increase the utilization of nitrogen for the synthesis of protein. Sulphur synthesized some sulphur containing amino acids like cysteine and methionine and resulted in increased protein content, which is in accordance with the findings of Hunashikatti *et al.*, (2000a), Gautam (2012) and Verma and Nawange (2015). Increasing of the rate of applied sulphur from 20, 40 and 60 kg S ha⁻¹ significantly increased N, P, K and S contents of cauliflower curd. These results are in agreement with those reported by Bhagavatagoudra and Rokhade (2001).

Effect of sulphur on quality attributes

Application of different sulphur doses had significant effect on chlorophyll content of leaves (Table 2). The maximum value of chlorophyll (1.46 mg g⁻¹) content was recorded with 60 kg S ha⁻¹ which was statistically at par with 40 kg S ha⁻¹. The minimum chlorophyll content of leaves was

recorded in S₀ (control). The mean increase in chlorophyll content of leaves under S₂ treatment was found to be 31.43 and 10.40 per cent over S₀ and S₁, respectively. Application of sulphur has been reported to help in lowering soil pH resulting in increased availability of several nutrients or might be due to the activation of a number of enzymes, energy transformation, chlorophyll formation and also in carbohydrate metabolism (Tandon, 1986). Due to sulphur fertilization, xylem and collenchymas fiber are also reported to be thickened resulting into more pronounced growth of plant. Increasing vegetative growth of cauliflower due to sulphur fertilization in the present investigation are in close conformity with the finding of Meena (2004) and Bhagavatagoudra and Rokhade (2001). Sulphur also plays an important role in the production of chlorophyll. It was found that the sulphur increased the chemical and biological activation of iron in the leaves resulting in increased chlorophyll content (Chhipa, 2005).

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 nutrient content in curd as well as improving the soil condition by providing more nutrients, 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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