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Research Article

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^{-} and q ha^{-1}), volume of curd (CC), 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. *botryitis* 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 ^{0}C and the temperate types require a temperature of 10 to 16 ^{0}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 ^{o}C for 6 weeks. Temperate types require vernalization at 7 ^{o}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, Rajsamand, 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 B_1, 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 SO_2 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 SO_2 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 SO_4–S 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 maximum and minimum during the growing season of cauliflower fluctuated 37.2^0C and 2.1^0C, 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/m^2. 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 F_0, F_1, F_2 and F_3 and Sulphur (control, 20, 40 and 60 kg ha^{-1}) denoted by S_0, S_1, S_2 and S_3. The recommended dose of NPK for cauliflower is 120 kg, 80 kg and 80 kg per ha respectively. Full dose of P_2O_5, K_2O 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 F_3 *i.e.* 125 per cent recommended dose of NPK, which was found to be significantly higher over F_0 and F_1 but it was statistically at par with F_2 *i.e.* 100 per cent recommended dose of NPK, whereas, minimum volume of curd (150.77 CC) was recorded under F_0 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 (F_3) followed F_2 and F_1. 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 F_3 was found significantly more over to F_0 and F_1 but it was statistically at par with F_2 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 (F_2) was statistically at par to 125 per cent recommended dose of NPK (F_3) 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), Everaarst and Boou (2000), Yaldas *et al.* (2008) and Abd el-All and EL- Shabrawy (2013).

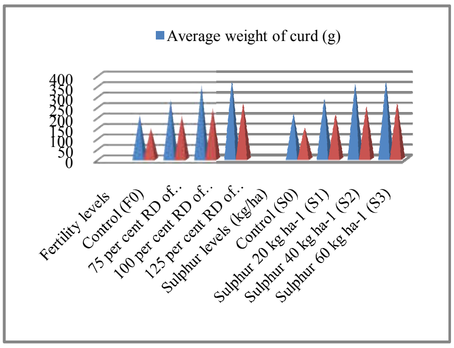

Fig. 1 Effect of NPK and sulphur on average weight of curd and volume of curd

Effect of NPKs on economics

Data (Table 1) Shows that the application of different fertility levels significantly influenced the net return and B:C ratio of cauliflower. The application of F_3 *i.e.* 125 per cent recommended dose of NPK significantly recorded maximum net returns (288879) and B:C (3.68) to control and F_1. Though the minimum net returns (140942) and B:C (2.00) was recorded under F_0. The application of 125 per cent recommended dose of NPK (F_3) remained statistically at par with 100 per cent recommended dose of NPK (F_2) in case of net returns.

Effect of sulphur on economics

The data pertaining to economics of cauliflower are presented in Table 1 further showed that the application of different sulphur doses significantly increase the net returns and B:C ratio of cauliflower. The application of 60 kg S ha^{-1} fetched significantly maximum net returns (291375) and B:C ratio (3.80) to control and S_1.

Table 1 Effect of NPKs and 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 (F_0)	213.83	150.77	3.42	105.60	140942	2.00
75 per cent RD of NPK (F_1)	286.65	211.36	4.59	141.56	208078	2.77
100 per cent RD of NPK (F_2)	358.73	247.35	5.74	177.15	277677	3.61
125 per cent RD of NPK (F_3)	371.68	264.65	5.95	183.55	288879	3.68
SEm$\pm$	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
Sulphur levels (kg/ha)						
Control (S_0)	214.18	147.12	3.43	105.77	137554	1.84
Sulphur 20 kg ha^{-1} (S_1)	286.28	212.52	4.58	141.37	208064	2.76
Sulphur 40 kg ha^{-1} (S_2)	358.39	248.18	5.73	176.98	278583	3.66
Sulphur 60 kg ha^{-1} (S_3)	372.05	266.31	5.95	183.73	291375	3.80
SEm$\pm$	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} which was statistically at par with 40 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 to 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^{-1}), 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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