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Evaluation of 'Target yield' approach of fertilizer recommendation on yield and economics of cauliflower (*Brassica oleracea* var. *botrytis* L.) in Mollisols of Uttarakhand

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Abstract
A field experiment was conducted at Crop Research Centre, G.B. Pant University of Agriculture and Technology Pantnagar, Uttarakhand during 2016-17 to evaluate the target yield approach of fertilizer recommendation on yield and economics of cauliflower in Mollisols of Uttarakhand. The experiment was laid out in the Randomized Block Design (RBD) with ten treatments and three replications. The treatments consisted Control (T_1), GRD (T_2), TY_1 (250 q ha^{-1}) (T_3), TY_2 (300 q ha^{-1}) (T_4), TY_1 (250 q ha^{-1}) +10 t ha^{-1} FYM) (T_5), TY_1 (250 q ha^{-1}) +20 t ha^{-1}FYM) (T_6), TY_2 (300 q ha^{-1}) +10 t ha^{-1}FYM (T_7), TY_2(300 q ha^{-1}) +20 t ha^{-1}FYM (T_8), 10 t ha^{-1}FYM (T_9) and 20 t ha^{-1} FYM (T_{10}). It is clearly indicated that target yield approach treatments both chemical and under INM mode are significantly superior over general recommended dose (GRD). Economic analysis of this experiment clearly reveals that response of fertilizer and net returns under target yield approach were higher as compared to GRD.

Keywords: Cauliflower, Mollisols, target yield, general recommended dose

Introduction
Cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most popular vegetable crops among the cole crops and has originated from the Mediterranean region. It was introduced to India in 1822. Cauliflower belongs to family brassicaceae and is grown for its white tender curd which is used for vegetable, curry, soup and pickle preparations. The name cauliflower originated respectively from the Latin words 'caulis' and 'floris' meaning cabbage and flower. The edible part of this vegetable is about 45% of the plant. (Rai and Yadav, 2005) [6]. Besides being good source of protein and carbohydrates, cauliflower is a rich source of vitamins and minerals (Bana *et al*., 2012) [1]. India ranks second in area and production of cauliflower in the world after China. India contributes approximately 13 per cent of the world's vegetable production and ranks first in the world's cauliflower production, second in onion and third in cabbage production. In India major cauliflower growing states are West Bengal, Bihar, Maharashtra, Madhya Pradesh, Orissa, Gujarat, and Haryana, etc. In India, cauliflower occupies an area of 453 thousand ha with a production of 8668 thousand MT while in Uttarakhand cauliflower occupies an area of 3.18 thousand ha with a production of 41.97 thousand MT (Horticultural Statistics, 2018) [4]. With the adoption of high yielding varieties and improved production technologies, there has been a significant increase in both vegetable production and productivity. At the same time, indiscriminate use of chemical fertilizers has resulted in many problems such as soil productivity degradation, pollution of the environment, depletion of non-renewable energy sources, etc. It requires balanced and sufficient supply nutrients for better growth and higher yield. Targeted yield (TY) approach strikes a balance between fertilizing the crop and fertilizing the soil. Here, the recommendations are more quantitative, precise and meaningful because combined use of soil and plant analysis is involved in it. In this approach fertilizer prescription equations were generated by conducting field experiment as per technical program of AICRP on Soil Test Crop Response (STCR). By utilizing the data of yield, soil test value and uptake, fertilizer prescription equations generated which are used for fertilizer recommendations at various yield targets and soil test values. However, evaluation of these equations is essential to verify their validity for sound soil test based fertilizer recommendation. In present study, an attempt has been made to evaluate target yield approach of Fertilizer Recommendation on yield of cauliflower (*Brassica oleracea* var. *botrytis* L.) in Mollisols.

Materials and Methods

The field experiment was conducted at Crop Research Centre, G.B. Pant University of Agriculture and Technology Pantnagarduring 2016-17. The ten treatment, Control (T_1), GRD (T_2), TY_1 (250 q ha^{-1}) (T_3), TY_2 (300 q ha^{-1}) (T_4), TY_1 (250 q ha^{-1}) +10 t ha^{-1} FYM) (T_5), TY_1 (250 q ha^{-1}) +20 t ha^{-1}FYM) (T_6), TY_2 (300 q ha^{-1}) +10 t ha^{-1}FYM (T_7), TY_2(300 q ha^{-1}) +20 t ha^{-1}FYM (T_8), 10 t ha^{-1}FYM (T_9) and 20 t ha^{-1} FYM (T_{10}) were evaluated in Randomized Block Design with the three replications. Details of treatments are given in table 1 and the layout of the experiment is given in figure 1.The seed of cauliflower was sown in the beds of 3×1 m size in the last week of September. One month old seedlings of uniform height (about 15-20 cm) were selected and transplanted in plots of size 4×3m at spacing of 60×50cm. Full dose of phosphorus, potash and half dose of nitrogen was applied as basal dose, while remaining half dose of nitrogen were applied at 30 days after transplanting. The source of nitrogen, phosphorus and potash were urea, single super phosphate and muriate of potash, respectively. Well decomposed farm yard manure (FYM) was also used as organic source. All cultural operations were performed as per recommendations. Observations on yield were recorded from all treatments of each replication.

Table 1: Detail of treatments

Treatment	Detail of treatments
T_1	Control
T_2	GRD (100:60:60)
T_3	Target Yield I-250 q ha^{-1} (145:80:102)
T_4	Target Yield II -300 q ha^{-1} (190:103:128)
T_5	Target Yield I- 250 q ha^{-1} (118:74:93 +10 t ha^{-1} FYM)
T_6	Target Yield I- 250 q ha^{-1} (103:70:85+20 t ha^{-1} FYM)
T_7	Target Yield II-300 q ha^{-1} (160:95:118+10 t ha^{-1} FYM)
T_8	Target Yield II-300 q ha^{-1}(146:90:110+20 t ha^{-1}FYM)
T_9	10 t ha^{-1}FYM
T_{10}	20 t ha^{-1}FYM

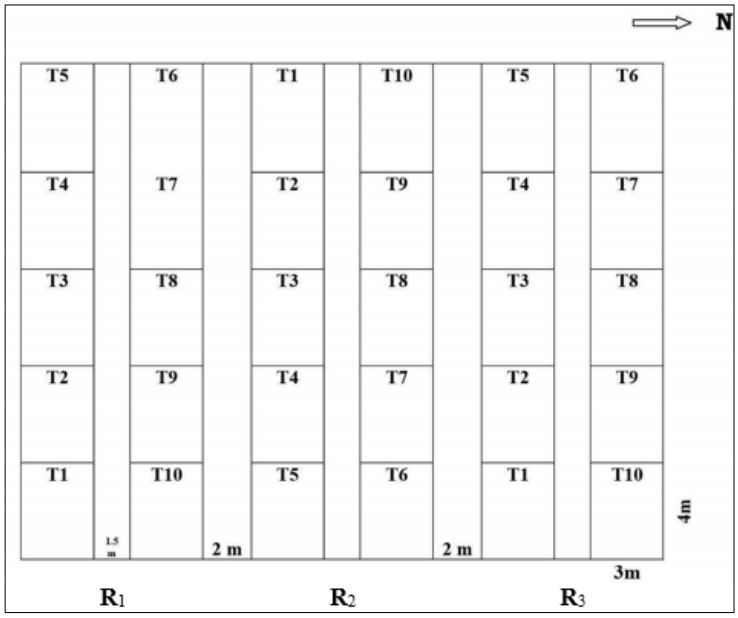

Fig 1: Layout of experiment

Economics of treatments: The economics of treatments is the most important consideration for making any recommendation to the farmer for its adoption. The prices of inputs that were prevailing at the time of their use were considered for working out the cost of cultivation. Gross return was worked out on the basis of market price of the produce at the time when the produce was ready for sale.Net return (Rs/ha) was calculated by deducting cost of cultivation (Rs/ha) from gross income. Benefit cost ratio (B/C ratio) was worked out as follows.

$$\text{B/C ratio} = \frac{\text{Net returns (Rs./ha)}}{\text{Cost of cultivation (Rs./ha)}}$$

Response ratio was also calculated by dividing additional yield to total fertilizer doses (N, P_2O_5 and K_2O).

Results and Discussion

Yield of cauliflower was significantly influenced by various treatments. The average curd yield of each treatment is given below in table 2 and also presented in figure 2.

Table 2: Yield of cauliflower under various treatments

Treatment	Yield (q/ha)
T_1	127.94
T_2	148.17
T_3	175.40
T_4	202.50
T_5	185.93
T_6	209.26
T_7	238.89
T_8	218.82
T_9	162.22
T_{10}	160.33
CD at 5%	12.71
S.Em.±	4.28
CV	4.05

On the basis of above table, it is clearly indicated that target yield approach treatments both chemical and under INM mode are significantly superior over general recommended dose (GRD). Similarly INM mode of fertilizer recommendation (T_7) at the rate of 10 t ha^{-1} FYM is significantly better than chemical mode of fertilizer with same yield targets (T_4).

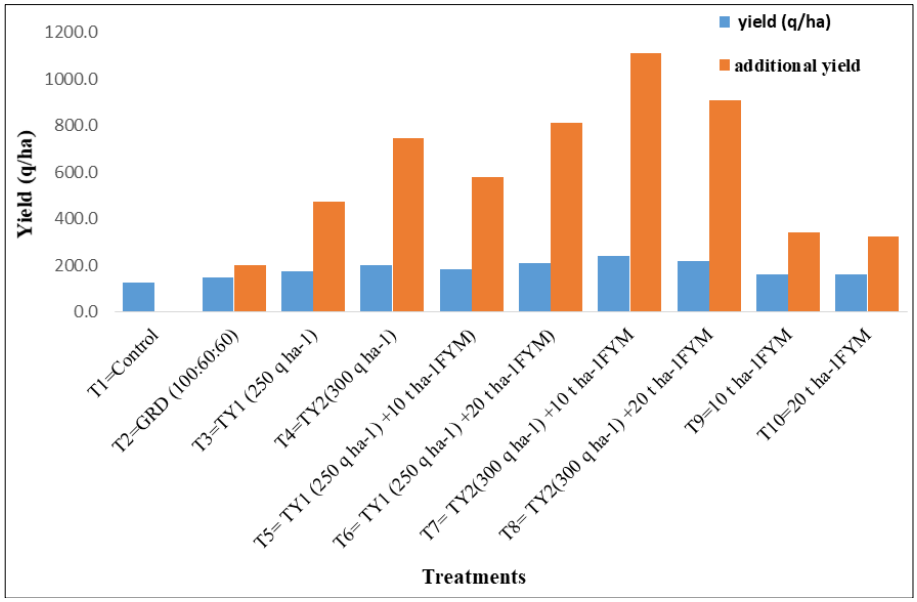

Fig 2: Cauliflower yield comparison among Control, GRD and STCR based fertilizer recommendations

Economic analysis of this experiment showed that all the treatments are superior over GRD as well as control. Net return was highest with 300 q ha^{-1} yield target with 10 t ha^{-1} FYM. Target yield 300 q ha^{-1} with 10 t ha^{-1} FYM is superior over chemical mode of fertilizer yield target. Data in table 3 indicated that the B/C ratio was higher where fertilizer recommended through STCR (inorganic) as compared to general recommended dose. Response ratio was better in both the yield targets both under chemical/INM modes over GRD. Similarly, response ratio was better in integrated targets as compared to chemical mode of targets in the experiment.

The relatively higher RR recorded under STCR under IPNS treatments when compared to GRD, might be due to balanced supply of nutrients from fertilizer, efficient utilization of applied fertilizer nutrients in the presence of organic sources and the synergistic effect of the conjoint use of organic sources of nutrients (Rao and Srivastava 1999) [7]. Fertilizer prescription equations for potato under the Integrated Plant Nutrition System (STCR-IPNS) have been demonstrated in the fields of farmers and it has been found that more than 90 per cent of the targets have been achieved. The STCR-IPNS for 40 t ha^{-1} recorded relatively higher response ratio (38.05 kg kg^{-1}) and benefit-cost ratio (15.3) over other treatments indicating the validity of the equations for prescribing fertilizer doses for potato (Gayathri *et al*., 2009) [3]. Similar result was also reported by Sharma *et al.* (2005) [8], Yanthan *et al.* (2010) [10], Thilagam (2011) [9], Pande and singh (2016) [5] and Dhinesh *et al.* (2017) [2].

Table 3: Economics of cauliflower under various treatments

Treatments	Fertilizer dose N-P-K (kg ha^{-1})	Yield (Kg ha^{-1})	Cost of fertilizer (Rs.)	Net return (Rs.)	B/C ratio	Response Ratio
Control	0-0-0	12794	0	0.0	0	0
GRD	100-60-60	14817	5681.8	14544.9	2.6	9.2
TY1 (250 q ha^{-1})	145-80-102	17540	8321.9	39135.9	4.7	14.5
TY2(300 q ha^{-1})	190-103-128	20250	10660.8	63901.3	6.0	17.7
TY1 (250 q ha^{-1}) +10 t ha^{-1}FYM)	118-74-93	18593	22472.5	35513.4	1.6	20.3
TY1 (250 q ha^{-1}) +20 t ha^{-1}FYM)	103-70-85	20926	36885.6	44433.7	1.2	31.5
TY2(300 q ha^{-1}) +10 t ha^{-1}FYM	160-95-118	23889	24653.6	86295.3	3.5	29.7
TY2(300 q ha^{-1}) +20 t ha^{-1}FYM	146-90-110	21882	39030.9	51851.0	1.3	26.3
10 t ha^{-1}FYM	0-0-0	16222	15000	19282.2	1.3	380.9
20 t ha^{-1}FYM	0-0-0	16033	30000	2393.3	0.1	180.0

Cost of cauliflower= 10 Rs. /kg, FYM cost= Rs.150/q, N, P_2O_5 and K_20 cost (Rs. /kg) = 11.65, 47.54 and 27.74 Rs. /kg

Conclusion

Fertilizer recommendation on the basis of target yield approach proved to be significantly superior over general fertilizer recommendation. Economic analysis of this experiment clearly reveals that response of fertilizer and net returns under target yield approach were higher as compared to GRD. B/C ratio was higher at both the yield targets under chemical mode.

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