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A REVIEW ON THE PRODUCTION AND YIELD OF CAULIFLOWER IN RELATION WITH ROW SPACING AND VARIOUS NITROGEN LEVELS

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ABSTRCT

This article highlights the literature pertaining to cauliflower growth and yield production effected by different levels of nitrogen and plant spacing in various part of the world. This intends the production and yield of the cauliflower for human use as well as forage. The main findings of most of important research works are briefly reviewed and presented in separate paragraphs.

INTRODUCTION

Cauliflower (*Brassica oleracea*) belongs to crucifer family generally termed as cole crops. It is a cool season crop and consumed as raw or cooked.

The soil that is rich in nutrients and having high moisture holding capacity is usually recommended for cauliflower cultivation. Nitrogen at 80 lbs per acre is usually the general recommendation for cauliflower.

The growth and yield of cauliflower is primarily affected by the attack of Insects but different row spacing and nitrogen availability also affects it growth, yield and production. Head size of cauliflower is largely affected by plant spacing. Wider plant spacing produces head of larger size and narrow row spacing produces smaller heads and same is in the case of nitrogen.

Keeping in view the importance of row spacing and nitrogen levels, this review is generalized to gather all the necessary information about row spacing and nitrogen levels that affected the production of cauliflower in various trials.

REVIEW OF SOME MAIN FINDINGS OF PREVIOUSLY REPOTED RESEARCH WORKS

White and Forbes (1976) planted cabbage hybrid, 'Rio Verde', at spacing of 9, 12, and 15 inches in rows on 30-inch centers and in 3-row beds on 60-inch centers, under 3 levels of fertilization at

Stanford. Yield responses, average weight of heads, and percent marketable cabbage data were taken on 3 plantings to represent fall, winter, and spring crops. Highest marketable yields for all three plantings were obtained on the 30-inch rows with plants spaced 12 inches and the high fertilizer rate. The average head weight was 3.8 pounds for this treatment. The lowest marketable yield was with 3 row beds at 9-inch spacing and the low fertilizer rate.

Whitwell and Senior (1986) screened different cultivars of cauliflower (Plana, Revito, Linas, Cervina, Vernon Channel Reef and Elby) with different row spacing (640 mm, 440 mm and 240) for better curd and head production. The results of the study showed size and depth of the curds were significantly decreased by narrow spacing whereas cutting length and cutting dates distribution was not influenced by plant spacing. Regarding cultivars the first three cultivars maximized the yield and quality whereas the later 2 only increased the yield but not the quality. It was concluded from the results that cultivar plana plant spaced with 600 mm × 440 mm is recommended for obtaining better growth and yield of cauliflower.

Islam *et al.* (1990) studied the influence of planting date and spacing on the growth and yield of Kartika variety of cauliflower at BINA, Mymensingh. The maximum plant height, number of leaves plant^{-1} at harvest and leaf size were obtained from 20 and 30 September planting and decreased gradually with the subsequent plantings. Similarly these were better with the plants given wider spacing (60x60 cm) than the closer spacing (60x50 cm and 60x40 cm). Bigger curds were produced by the seedlings planted on 20 (1.06 kg) and 30 (1.07 kg) September in combination with 60x60 cm. But maximum yield of 28.10 ton and 28.32 ton ha^{-1} were given by the plantings done on 20 and 30 September respectively with a spacing of 60x40 cm.

Markovic *et al.* (1990) conducted that during 3 years investigations to investigate influence of different quality of nitrogen (0 to 200 kg ha^{-1}) on the yield quality and basic nutritive elements accumulation in Cauliflower. Varying doses of nitrogen were applied to two cauliflower varieties (Snowball and Imperial). Different parameters such as dry matter proteins, Ascorbic acid, nitrates (NO), nitrites (NO) and N, P, K, Ca, Mg and Fe accumulation in all above ground parts were studied. They reported that yield of cauliflower was increased by increasing nitrogen from 0-200 kg ha^{-1} and quality was not significantly effected except vitamin C, which increased with increasing nitrogen quantity. The basic nutrient elements accumulation was increased with increasing yield of above ground parts of plants.

Aditya and Ahmad (1990) designed an experiment to investigate the method of producing cauliflower seed by growing plants in close spacing and by optimum application of water and inorganic nitrogen. Highest seed yield (243 kg ha^{-1}) was taken by fertilizing the plants with 140 Kg N ha^{-1} accompanied with two irrigation per week (112m (3) ha^{-1}). The second highest yield (233 kg ha^{-1}) was obtained by one irrigation per week (56 m (3) ha^{-1}) along with same quantity of inorganic nitrogen. Deficiency of nitrogen depressed plant growth and seed yield.

Bjelic (1994) reported that the fertilization of cauliflower provoked an intensive curd development in comparison to the untreated control. Curd diameter was mainly affected by nitrogen and the weight registered was up to 120 kg ha^{-1}. However, increased phosphorus and potassium amounts had no effect on curt diameter. On the average, cauliflower yield was 25.34 t ha^{-1}. Yield increase, up to 11.26 t ha^{-1}, was significantly affected by fertilization. Nitrogen has

significantly influenced yield increase, phosphorus and potassium had minor influence on yield. Increased nitrogen amounts as well greater phosphorus and potassium amounts had no significant effect on cauliflower yield above 120 kg ha^{-1}.

Bracy et al. (1995) conducted field studies in fall 1991 and 1992 to determine. The optimum seed spacing necessary to directly seed cauliflower to a stand. Seed spacing of 10, 20, and 30 cm at one seed per hill and 30 cm at two seeds per hill were evaluated for effect, on yield, head weight, plant population, and early harvest percentage. As evaluated in the laboratory, seeder precision (accuracy) was good in regard to seed counts and spacing measurements at the various seed spacing. In the field, seeder precision varied in distribution patterns among seed spacing and years. Cauliflower directly seeded at one seed per hill and a 20-cm spacing produced yields and head weights similar to cauliflower seeded 10 cm apart and thinned to 30 cm.

Csizinszky (1996) initiated experiments to investigated the yield potential of 'Alverda' green cauliflower in three consecutive plantings (10 Oct. and 24 Nov. 1992 and 12 Jan. 1993) at two in-row spacings (31- and 38-cm) with the factorial combinations of N and K at 98, 196, and 294 kg ha^{-1} under subtropical conditions. Crops were grown in an Eau Gallie fine sand with the full-bed polyethylene mulch-seepage (modified furrow) irrigation system. Marketable yields were highest in the January planting with N at 294 kg ha^{-1} when 71% of the plants had marketable size (≥0.34 kg) and desirable quality curds. Yields were higher at 38- than at 31-cm spacing. Yields and curd size increased with increasing N rates at all three planting dates ($P \leq 0.01$). Potassium rates had no significant effect on yields.

Markovic et al. (1996) assessed the influence of increasing nitrogen levels (0-200 kg ha^{-1}) on the yield and nitrate (NO_3) and nitrite (NO_2) content in vegetable crops on the chernozem soil. Yield of garden radish, carrot and beetroot was increased with increasing doses of nitrogen until to 50 kg ha^{-1}, at spinach, broccoli and cabbage until 100 kg ha^{-1}, and cauliflower until to 200 kg ha^{-1}. Nitrate content with increase of nitrogen in fertilization investigated crops was increased at spinach, cauliflower and carrot but at garden radish, broccoli and beetroot was not significant changed. Nitrite (NO_2) content at investigated crops fertilization was increased at carrot and beetroot only.

Batal et al. (1997) studied the influence of N, Mg, and B on growth, yield and hollow stem incidence of cauliflower (*Brassica oleracea*, Botrytis group) cvs. White Empress and Stovepipe. Maximum curd weight and yield were recorded by treating cauliflower with 269 and 381 kg ha^{-1} respectively. The yield was not affected by increasing Mg from 22.5 to 90 kg ha^{-1}. Furthermore, the incidence of hollow stem was significantly minimized by the treatments given. The incidence of hollow stem was reduced by increasing B from 2.2 to 8.8 kg ha^{-1} curd weight and yield was not significantly affected by it.

Wurral *et al.* (1998) White cabbage type and maturity characteristics of the curd of Fox setting temperatures on the plant, transplant age, N top dressing and determine the influence of irrigation. Starting curd and yogurt in any maturity day were not affected by treatment. While the number of leaves was significant.

Babik and Elkne (1999) studied the effect of nitrogen fertilization (100, 200, 400 and 600 kg N ha^{-1}) and irrigation (normal and a field capacity exceeded 30 KPa) on yield and quality of broccoli. Nitrogen at 400 and 600 kg ha-1 and irrigation significantly increased plant weight and yield, reduced days to head formation. Nitrogen content was significantly higher in one application of nitrogen as compared to split application but usually the same for irrigated and non-irrigated plants. Higher rates of nitrogen and irrigation increased hollow stem incidence of broccoli. With high nitrogen fertilization, sugars and nitrates content enhanced but decreased vitamin C and fiber content. Nitrate content was minimized by Irrigation while the sugar level, ascorbic acid and beta carotene did not change as compared to broccoli from non-irrigated treatments.

Csizinszky (2003) investigated the yield potential of 'Alverda' green cauliflower in three consecutive plantings (10 Oct. and 24 Nov. 1992 and 12 Jan. 1993) at two in-row spacings (31- and 38-cm) with the factorial combinations of N and K at 98, 196, and 294 kg ha^{-1} under subtropical conditions. Crops were grown in an Eau Gallie fine sand with the full-bed polyethylene mulch-seepage (modified furrow) irrigation system. Marketable yields were highest in the January planting with N at 294 kg ha^{-1} when 71% of the plants had marketable size (≥0.34 kg) and desirable quality curds. Yields were higher at 38 than at 31-cm spacing. Yields and curd size increased with increasing N rates at all three planting dates ($P \leq 0.01$). Potassium rates had no significant effect on yields.

Amoli et al. (2004) determine the best planting date, plant density and urea fertilizer levels for high yield in cauliflower var. Snow crown, a spilt-Plot factorial design with three replications was carried out at Dashtenaz Agricultural Research station in Sari for two year (2003-2004). The main plots were included as three planting dates, 5 Sep. 20 Sep and 5 Oct and also subplots were considered as three different plant row distance, 50, 60 and 70 cm and three different levels of urea fertilizer 0, 200 and 300 kg ha^{-1}. Analysis of variance based on split – factorial design revealed significant mean squares of main factor, sub factors and also their interactions at 1% probability level. Duncan's test showed the A1B2C2 treatment (A1): planting date on 5 September, B2: between and within plant row distances were considered 60 and 30 cm respectively and C2: 200 kg ha^{-1} urea fertilizer with 40 ton yield ha^{-1} had highest yield. Increasing plant numbers due to reduce of plant row distances from 70 to 50 increase yield. Most of studied traits had significant Pearson's correlation's with each other at 1% probability level Significant positive correlations were observed between yield and each of two traits including curd diameter and leaf dry weigh with 0.585 and 0.580 coefficient correlations, respectively and also significant positive correlation (r= 0.842) was observed between curd diameter and yield. The results of stepwise regression analysis revealed that curd diameter and leaf dry weight had important effects on yield.

Muhammad et al. (2004) studied the influence of nitrogen levels (0, 40, 80, 120, 160 and 200 kg N ha^{-1}) on onion varieties (Shah Alam, Faisalabad Early and Phulkara). The results for bulb size, survival, diameter and marketable yield $plot^{-1}$ for the three cultivars were non-significant. Whereas, nitrogen at 120 kg ha^{-1} significantly improved leaf length, cull percentage and total yield t ha^{-1}.Shah Alam proved to be the best regarding value cost ratio as compared to the other two varieties. It is concluded that cultivar Shah Alam fertilized with nitrogen at 120 kg ha-1 is recommended for obtaining better growth and yield of onion.

Hill (2007) checked the influence of plant spacing (45×45, 50×50, 55×55 and 60×60 cm) and nitrogenous (N) fertilizer (0, 50, 100, 200, 300 and 400 kg N ha^{-1}) on the growth and yield of cauliflower. Plants fertilized with 200 and 300 kg N ha-1 plant spaced 45×45 cm produced more marketable yield. Increased nitrogen levels significantly increased plant width but did not significantly affect Plant height.

Rather and Schenk (2008) investigated the effect of nitrogen (optimum and limiting solution of 6.8 and 2.6 g $plant^{-1}$ respectively) on curd compactness and yield of cauliflower (*Brassica oleracea* var. *botrytis*). Bolting started 4 days before with limiting N supply as compared to optimum N supply. Onset of bolting was not significantly affected by the foliar application of the GA_3 (10 mg plant) and chlorcholinchloride (100 mg plant). Benzylaminopurine (BA, 40-320 µg plant) delayed bolting by three and four days at optimum and limiting N supply, respectively.

Muhammad et al. (2007) investigated the effect of different doses of NPK fertilizers on cabbage growth and yield (cv. Golden Acre). Head weight, diameter, length, marketable heads and yield were significantly improved by NPK level of 120-90-60 kg ha^{-1}.

CONCLUSION

Plant spacing and different Nitrogen levels affects the growth and yield of Cauliflower when applied at vary stages of plant. This review significantly highlighted the proposed subject in a very brief way to emphasize its use as food for human and as forage for animals as well.

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