Review Article

FACTORS AFFECTING PRODUCTION OF CAULIFLOWER: A SYSTEMATIC REVIEW

ABSTRACT:

This article reviews the literature on different varieties, genetic variability, heritability and genetic advance, cauliflower growth and yield production influenced by different levels of nitrogen and plant spacing in different parts of the world. This aims to increase cauliflower production and yield for both human consumption and forage. The main findings of the majority of important research works are summarised and presented in separate paragraphs.

Keywords: genetic variability, heritability and genetic advance, yield, plant spacing, NPK level

Introduction:

Since India's population is mostly vegetarian, vegetables are the most important component of vegetarian diet of Indian population. The present production in India is approx 191.7 million metric tonnes of vegetable from 10.35 million hectare of land (NHB, 2019-20). Among the number of vegetables grown in India Cauliflower is one of the economically important vegetable of the winter season. According to FAO (2019), India is the largest producer of cauliflowers along with ginger and okra amongst vegetables and ranks second in production of potatoes, onions, brinjal, Cabbages, etc.

The cruciferae family includes cauliflower (Brassica oleraceae var. Botrytis). It is commonly known as "Phoolgobhi" and was introduced to India in 1822 by Dr. Jemson, of Botanical Plant, Saharanpur, Uttar Pradesh (Nath et al., 1994).It is utilised in pickles, soups, and curries. It is abundant in vitamins A and C, minerals, and carbs.The so-called tender and yellowish white curd, which is produced by the stem system with short internodes, is the reason it is grown. Cauliflower cultivation is typically recommended in soil that is rich in nutrients and has a high moisture holding capacity. Cauliflower growth and yield are primarily influenced by insect attack, but row spacing and nitrogen availability also have an impact on its growth, yield, and production. Plant spacing has a significant impact on cauliflower head size. In the case of nitrogen, wider plant spacing produces larger heads, while narrow row spacing produces smaller heads. With the importance of row spacing and nitrogen levels in mind, this review has compiled all of the necessary information about row spacing and nitrogen levels that affected cauliflower production in various trials. Since it is a sensitive crop, freezing weather might harm it just before harvest. In dry and hot weather, the plants may not produce the desired heads, which leads the heads to develop prematurely and bolt or button. During the time while it is growing, it needs moderately cool climates.

Review of Some Key Results of Earlier Reported Research works:

Varietal Reviews:

There are a number of varieties based on the curd size, time of yield, different agroclimatic conditions, commercial viability, etc. According to Minami and Victoria (1981), the best yields of commercially suitable curds in cauliflower cv. Snow Ball were obtained between 20830 to 25640 plants ha.According to Whitwell and Senior (1988), the best cultivars for curd yield and floret quality, Plana, Revito, Vernan, Linas, and Cerv ma, should be grown at 440 mm (3.8 plants m ').Mozumdar S.K. *et. Al* (2011) found that White shot and Balaka produced early curd, whereas Earlysnowball and Late alhead produced delayed curd. Snow queen, White contessa, Whiteshot, Balaka, and Rupa performed better in the 15 October planting, while Snow grace, Rupa, and Benarashi performed better in the 15 November planting. White contessagave produced the highest curd yield (21.42 t/ha), while Snow queen produced the highest BCR (7.95) in 15 October planting.Paudel T.R. *et.al.* (2019) reported that cultivar Snow Grace can generate the best yield when phosphorus is applied (160 kg ha-1), and that additional research is required to optimise the P rate for increasing production in the Nepal.

Review based on Genetic variability:

All plant improvement programmes are built on genetic variability. If sufficient genetic variability exists, it can be used to create superior cultivars.Sharma and Verma (2001) investigated genetic variation and divergence in 9 cauliflower cultivars and discovered statistically significant differences in all traits. Cluster means in cluster 2 showed the highest values for gross weight per plant, curd yield per plant, curd diameter, leaves per plant, and days to curd maturity, while leaves per plant contributed the most to genetic divergence.

Ahmed et al., (2003) evaluated 10 cauliflower cultivars in Hathazari, Chittagong, Bangladesh and discovered that 'Shiroyama-65' had the highest value for whole plant weight (1916.67 g) and width of biggest leaf (22.17 cm), while 'Rakhushi Late' had the highest values for plant height (68.00 cm), number of leaves at harvest (25.93), and length of biggest leaf (22.17 cm) (56.03 cm).'Shiroyama-65' also produced the highest curd weight (661.67 g) and curd yield (18.38 tonnes/ha).

Thakur (2001) evaluated 36 cauliflower genotypes for various horticultural and quality traits and discovered wide genotypic differences for all traits except number of leaves per plant, curd diameter, and curd depth. Harvest index and gross weight had high heritability and high genetic advance, whereas plant spread and days to curd maturity had high heritability and low genetic advance.

Kumar et al. (2009) evaluated 15 exotic cauliflower genotypes and found a wide range of variability in stalk length from CGN-11089 (5.56 cm) to CCS-06-08 (9.5 cm). Sharma (2010) investigated the variability and inter-association of phenotypic characters in twenty-five genetically diverse cabbage lines. For all of the characters, there were significant differences between genotypes. Gross weight per plant and net weight of head had relatively high genotypic (GCV) and phenotypic coefficients of variation (PCV) expressed in percentage points.

Singh et al. (2013) tested twenty-four cauliflower genotypes, including hybrids and released/pre-released varieties. The analysis of variance revealed that genotype differences were highly significant for all of the characters. The maximum phenotypic coefficient of variation (PCV) was found in leaf length (21.04), followed by leaf weight (17.19), and the

lowest variability was found in days to maturity (7.01), followed by the number of leaves (9.05), and the number of inner leaves (9.22).

Studies on heritability and genetic advance:

Heritability is the percentage of phenotypic and genotypic variation that is passed down from parent to offspring. Genetic variability is largely determined by heritable variation, and higher heritable variations have a greater chance of being fixed by selection methods. Thus, heritability studies are critical in determining whether observed variation for a specific character is heritable or due to environment.Shakuntala and Kalia (2005) investigated quality trait variability in 11 genotypes of green sprouting broccoli. Ascorbic acid has a high heritability (99.20%) and a high genetic advance (78.11%), indicating that additive gene action plays a role in its inheritance. Protein content, on the other hand, had a moderate heritability (69.60 percent) and a low genetic advance (8.98 percent).

Antonova (2009) studied the heritability and genetic progress of some traits in open pollinated cultivars and selected new breeding lines of late head cabbage. Broad-sense heritability was high for the majority of the investigated characteristics, ranging from 45 to 92 percent. Head weight had the highest heritability, while vegetation period had the lowest.

Kanwar et al. (2010) reported high heritability with moderate genetic gain for days to marketable maturity, number of leaves, net curd weight, and curd compactness, indicating additive gene action and paving the way for successful selection breeding of these traits.

Qing et al. (2013) used six inbred lines to investigate combining ability and heritability in cauliflower. Narrow heritability was assigned to maturity, bracts rate, leaf coverage ratio, head height, ball diameter, and head weight in that order.

Soni et al. (2013) investigated heritability and genetic progress in sixteen cabbage genotypes grown in Lucknow. The results showed that vitamin C (99.50 percent), days to maturity (98.90 percent), core length (88.20 percent), head weight (87.30 percent), yield (87.20 percent), leaf width (83.40 percent), and leaf length (83.20 percent) had high heritability, whereas plant height (78.20 percent), equitorial length (72.70 percent), head polar diameter (71.60 percent), stalk length (71.20 percent), plant spread (69.80 percent (66.00 percent). For plant spread and vitamin C content, genetic advance as a percentage of mean ranged from 6.04 percent to 50.09 percent.

Studies based on phenotypiccharacteristics and growth requirements:

Kanisewsky and Rumpel (1998) Calcium nitrate produced the highest yield of cauliflower curds among the tested nitrogen fertilisers. The highest cauliflower yield was obtained on a low moor peat and a silty clay loam out of the five soil types tested. Nitrogen fertilisation increased nitrate nitrogen levels in cauliflower leaves and curds in a linear fashion. The nitrate nitrogen content of leaves and curds was influenced by cultivar, soil type, and nitrogen rate and form.

Csizinszky (2003) investigated the yield potential of 'Alverda' green cauliflower in three consecutive plantings (10 Oct., 24 Nov. 1992, and 12 Jan. 1993) at two in-row spacings (31- and 38-cm) with N and K factorial combinations at 98, 196, and 294 kg ha-1 under subtropical conditions. Crops were grown in fine sand from Eau-Gallie using a full-bed polyethylene mulch-seepage (modified furrow) irrigation system. Marketable yields were

highest in the January planting with N at 294 kg ha-1, with 71% of the plants having marketable size (0.34 kg) and desirable quality curds. Yields were higher at 38 cm spacing than at 31 cm spacing. At all three planting dates, increasing N rates increased yields and curd size (P 0.01). Potassium rates had no discernible effect.

During the growing season(2003-2004), Amoli et al. (2004) determined the best planting date, plant density, and urea fertiliser levels for high yield in cauliflower var. Snow crown. The main plots included three planting dates, 5 September, 20 September, and 5 October, as well as three different plant row distances, 50, 60, and 70 cm, and three different levels of urea fertiliser, 0, 200, and 300 kg ha-1. At the 1% probability level, the majority of the traits studied had significant Pearson's correlations with each other. Significant positive correlations were found between yield and two traits, curd diameter and leaf dry weight, with coefficient correlations of 0.585 and 0.580, respectively, and a significant positive correlation (r= 0.842) was found between curd diameter and yield.

Increase the plant density limits the availability of space for lateral growth, resulting in increase in plant height as reported by Pandita et al., (2005).

It is one of the popular winter vegetables in Bangladesh. Cauliflower thrives best in a cool moist climate and it does not withstand very low temperature or too much heat as reported by Din et al., (2007).

Hill (2007) investigated the effect of plant spacing (4545, 5050, 5555, and 6060 cm) and nitrogenous (N) fertiliser (0, 50, 100, 200, 300, and 400 kg N ha-1) on cauliflower growth and yield. Plants fertilised with 200 and 300 kg N ha-1 and spaced 4545 cm apart produced a higher marketable yield. Increased nitrogen levels increased plant width significantly but had no effect on plant height.

Rahman M. *et.al.* (2007) Plant spacing is an important factor for the growth and yield of cauliflower. Amongst various spacing, 45 cm spacing proved better results in all the aspects.

Rather and Schenk (2008) investigated the effect of nitrogen (optimum and limiting solutions of 6.8 and 2.6 g plant-1, respectively) on cauliflower curd compactness and yield (Brassicaoleracea var. botrytis). Bolting began four days ago with a limited N supply as opposed to an optimal N supply. The foliar application of theGA3(10 mg plant) and chlorcholinchloride had no effect on the onset of bolting (100 mg plant). Benzylaminopurine (BA, 40-320 g plant) delayed bolting by three and four days, respectively, at optimal and limited N supply.

According to Chaterjee and Mahanta (2013), results showed that planting dates and nutrient source have a significant effect on off-season cauliflower production, with 14th May planting being the best in terms of plant growth, curd yield, and quality. Again, inorganic fertilisers with vermicompost (5 t/ha) and biofertilizer seedling inoculation were recommended by 75 percent of the respondents as the best nutrient source for off-season cauliflower production. The results established that planting on May 14th, combined with 75 percent recommended inorganic fertilisers, vermicompost (5 t/ha), and bio fertilizer seedling inoculation, will result in desirable growth, yield, and quality attributes of offseason cauliflower under agro shade net.

Lavanya et al., (2014) recommended that early sowing (1st October) with closer spacing is suitable treatment combination for higher seed yield of radish. So, it is needed to optimize sowing date for quality seed production of cauliflower.

Often cauliflower gave severe negative response to unfavorable environmental conditions viz., extreme temperatures and droughts that lead to economic reduction as results of pre mature curd formation as found by Singh et al., 2014.

Hossain *et.al.* (2015)reported that because of the higher number of seeds pod-1, a combination of 1 October sowing and 60 cm 50 cm plant spacing produced the highest seed yield (414.81 kgha-1). Regardless of plant spacing, seed yield decreased after 10 October sowing. As a result, early sowing (1 October) with closer spacing (60 cm 50 cm) would be economically profitable for cauliflower seed production in Bangladesh's northwestern region.

Islam *et.al* (2016) found that the second planting date (30th November) had the significantly highest curding percentage (75.67 percent), while Remi had the significantly highest curding percentage among the varieties (83.97 percent). The 15th November planting produced the highest net curd weight (620.67 g), with White Excell recording the highest net curd weight (820.22 g). White Excell had the highest curd yield (26.39 t ha-1) followed by Remi (16.13 t ha-1) and Girija (16.13 t ha-1) (15.06 t ha-1). With the exception of Remi, the first planting date (15th November) was most suitable for cultivation of the cauliflower varieties Girija, White Excell, Remi, Pushpa, and White Marvel in the Terai region of West Bengal.

Joshi T.N. *et. al.* (2018) found that increased cauliflower plant height during his study may be due to larger plant spacing, which will be significant only up to an absolute limit; higher number of leaves in 52.545 cm spacing may be due to greater availability of resources for the growth and development of the leaves. The more space available, the better the exposure for photosynthesis for plants. Closer plant spacing resulted in poor results due to competition for nutrients, sunlight, and space for better curd growth and development. Low yield in close spacing may be due to a higher mortality rate, lower plant height and fewer leaves per plant, shorter curd diameter, and competitive growth of the plants.

Kaur M. *et.al.* (2018) found that spacing, on the other hand, has no effect on curd count, curd weight, curd yield, plant height, number of leaves per plant, spreading diameter, or stalk length. Two cultivars, RIJK-du (280.10 q/ha) and Denali RZ 26-960 (280.42 q/ha), were found to be promising for yield per hectare in phagwara region of Punjab.

Kumari R. *et.al.* (2019) reported that the main effect of sowing date and plant spacing, as well as their interaction effect, were significant. The results showed that the best germination percentage, seedling length, seedling dry weight, vigour Index-I and vigour index-II were obtained when seeds were sown on August 10th and transplanted at a spacing of 60 60cm. When the seed was sown on August 10th, the electric conductivity was the lowest.

Giri*et. al* (2020) concluded that Bishop was determined to be the best hybrid variety, with other suitable varieties including NS 106, Titan, Artica, and Snow Mystique for improved growth and higher curd yield in Chitwan conditions. Similarly, Freedom was identified as a short duration variety that can mitigate the negative effects of higher temperatures in late winter.

CONCLUSION

This paper's composition examined the variability, heritability, genetic advancement, correlation, path analysis, and genetic divergence available in cauliflower genotypes. It is popular among both rural and urban residents due to its good taste, but the lack of data on programme changes makes it difficult for agriculturists to gain the most prominent advantage.The late season cauliflower cultivars varied significantly in terms of plant growth metrics such as plant height and canopy diameter at various growth stages, curd yield at final harvest, along with curd initiation and curd maturity.It was also seen that nitrogen fertilization increased yield and improved curd quality without delaying harvest time.

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