Progressive Research – An International Journal
Vol. 4 (Special Issue) : 489-494 (2009), ISSN : 0973-6417

Society for Scientific Development in Agriculture and Technology, Meerut (U.P.) INDIA

PLANT NUTRITION AND POPULATION FOR SUSTAINABLE PRODUCTION OF INDIAN CAULIFLOWER—A REVIEW

Mahesh Kumar
College of Horticulture, Noorsarai, Nalanda, Rajendra Agricultural University, Pusa, Samastipur, Bihar
Email : maheshcoh07@gmail.com

ABSTRACT

Cauliflower (*Brassica oleracea var. botrytis* L.) *is* one of the most important vegetable crops, belonging family- *Cruciferae* and occupies the largest area in India. At present the influx of hybrid is more common due to their comparatively higher yield potential coupled with desirable qualities, make it imperative to work out their agronomy for harnessing maximum possible benefits from their cultivation. Nutritional needs and space required for optimum growth and development of individual plants appear to be the fore and foremost agronomical aspects demanding revelation and quantification with precision. Comparing production potential, suitable spacing and there by plant population per unit area, quantifying nutritional needs curd quality and production economics of Indian cauliflower.

Key words : Plant nutrition, plant densities, indian cauliflower and sustainable production.

INTRODUCTION

Cauliflower (*Brassica oleracea* var. botrytis L.) belonging family-*Cruciferae* is one of the most important vegetable crops grown worldwide. Earlier, it was grown only as winter vegetable in India, but with the evolution of Indian cauliflower it is being grown during summer and rainy season also. Grown for its tender white curd formed by condensed flower stalks, it is used as a vegetable in curries, soup, pickles. Pieces of cauliflower (buttons) can be fried with *besan* for preparation of *pakoras*. Cauliflower is raised in autumn and winter months in India. It is a thermo sensitive crop based on its temperature requirement for curd initiation and development, it is classified into early maturity group (26^{o}C-20^{o}C), mid early maturity group (16^o-20^{o}C) mid late maturity group (12^o- 16^{o}C) and late or Snowball maturity group (10^{o}C-16^{o}C). (Swarup and Chatterjee, 1972). The curd is a natural source of nutrients especially protein, carbohydrate, phosphorus, ascorbic acid (Vitamin C) and minerals. India ranks first in production and area contributing about 5% of the world's production. According to National Horticulture Board data base 2005, the total area, production and productivity of cauliflower in India for the year 2004 was 2.38 lakh hectare, 4.51 million tones and 18.9 ton/ha, respectively.

At present the influx of hybrid is more common in vegetables. In almost all the vegetable crop, various seed agencies as well as the SAU'S have come up with a large number of hybrids .Cauliflower is one of the vegetable crops in which hybrids are attracting farmers the most. These hybrid evolved in vegetable crops are capable of changing the agricultural scenario of the country and economic status of the vegetable farming communities. However, the advents of hybrids simultaneously demand defining proper agro-techniques for their cultivation. The hybrids in general have greater yield potential than the existing improved open pollinated varieties. A crop yielding more is bound to extract more nutrients from the soil, which shall have to be replenished by computing proper doses of fertilizers. The yield potential and nutrient uptake are reciprocal. If the yields are higher, the fertilizer dose shall also have to be kept higher. Thus, it is imperative to quantify nutritional needs of newly evolved hybrids. However, very little information are available regarding the fertilizer needs of Indian cauliflower and also the optimum spacing required for planting.

Importance of plant nutrition in cauliflower : For proper growth and development, cauliflower requires different major and minor elements in which nitrogen, phosphorus and potash are very important. Of these nitrogen is the most important. It has the most pronounced and quickest effect. It plays very significant role in building protein, amino acids and various other organic compounds. Increasing the protein content of food, it also governs the utilization of potash, phosphorus and other elements, making the whole plant deep green with succulent tender curds. Phosphorus is another important element which is an important constituent of cell wall, nucleic acid, lipids and phospholipids. Availability of sufficient phosphate is also essential for nitrogen uptake, promotion of root growth and development of curd. Potassium provides resistance to disease and enhanced flowering. It provides strength to them and prevents lodging. Dhesi *et al*. (1964) reported that the response to different levels of nitrogen of cauliflower was statistically significant. Application of 224 kg N/ha gave the maximum profit of Rs. 2865.16. The curd yield increased with every increase in the dose of nitrogen. Razvi and Jagirdar (1967) did not observe any significant yield differences in cauliflower between farm yard manure, goat manure cotton dust of (NH_4) SO_4 applied at equal N rates. Chaudhuri and Yawalkar (1969) observed that the yield of marketable curd of cauliflower was significantly increased by doses of nitrogen, (67.25 and 134.50 kg N/ha) by 45 and 75 per cent respectively over control. Pimpini (1971) reported that fresh weight of curds, leaves; stalks and roots of cauliflower were positively related to the N level. The effect was greater on curds than on leaves. He observed that at high N levels root growth of cauliflower was particularly stimulated and maturity was delayed. Roy (1981) reported an increase in curd diameter from 15.1 – 20.2 cm and yields from 108.3-261.4 q/ha by increasing the levels of N from 50-200 kg/ha in a period of 3 years with cv. Dania. He, however, suggested 100 kg N/ha as the most economical N rate which gave a yield of 251 q/ha, the diameter of curds being 20 cm. Sharma and Arora (1984) in a trial with cv. Improved Japanese reported increased dry matter yield and curd yield by increasing the nitrogen level from 0 to 180 kg/ha. Application of half the dose of N at transplanting and the rest 40 days later showed higher yield than application of the entire dose of fertilizer at transplanting. With little removal of N via the curds, the amount of N added to the soil via plant foliage left in situ should be considered while calculating the subsequent seasons N-fertilizer requirement in order to minimize nitrate leaching following excessive build up in the soil. Markovic and Diurovk (1990) obtained highest yield of 13.00 t $ha^{-1}$of cv.Snowball by applying 200 kg N/ha as compared to 8.0 t ha^{-1} in the control. The quality parameter did not show any significant difference between the N treatments but showed more variation from year to year. Thakur (1991) studied the effect of different levels of nitrogen viz., 80,120, 160, 200 and 240 kg N ha^{-1} on growth and yield of cauliflower. The increasing rate of N application delayed curd maturity and increased dry matter content, leaf area and curd maturity. Rahn *et al*. (1992) two cauliflower cultivars were grown in succession on Wisbech silt loam soil of marine origin and each crop was supplied with N (as ammonium nitrate) at 0, 60, 120, 240 or 300 kg/ha. The first crop was given at least 120 kg N/ha, the yields of the second crop (which averaged between 33000 and 34000 curd/ha) were not increased by further N application at planting. Kotur (1993) reported that urea coated with neem extract applied in two split doses gave the highest yields (4.1 and 89.7 t ha^{-1}) for cauliflower and Aubergine, respectively. Yang *et al.* (1994) found that the higher nitrogen application rate increased nitrate reductase activity and decreased leaf nitrate-nitrogen content in cauliflower. At the lower nitrogen rate, the higher potash rate increased nitrate-reductase activity and leaf nitrate-nitrogen. There was no correlation between leaf nitrate reductase activity and curd yield. Fareg *et al.* (1994) found that curd weight, curd diameter, total curd yield and leaf nitrogen content in cauliflower increased with the increasing nitrogen application rate but date of curd formation was delayed. Balyan and Singh (1994) held an experiment on cauliflower cultivar Snowball-16 and reported that nitrogen application significantly affected the uptake of phosphorus and zinc by the crop. The interactive effect of nitrogen + phosphorus and nitrogen + zinc on the uptake of nitrogen, phosphorus and zinc were similar to their effects on marketable yield. The best rate of nitrogen was 120 kg ha^{-1}in terns of yield. Baghel and Singh (1995) studied the different doses of nitrogen, potash and dates of planting on cauliflower revealed that higher doses of nitrogen and potash increased the yield significantly. The increased yield of 25.01per cent to 27.6per cent was due to higher dose of nitrogen while 7.7 to 9.2 per cent more yield were recorded in higher dose of potash. Terate *et al.* (1995) revealed that nitrogen application of 50 to 400 kg/ ha^{-1} along with sufficient amount of phosphorus and potash increased the amount of chlorophyll by 70-80% and the leaf area by 90-100% in cauliflower as compared with unfertilized control plants. Further he reported that application of nitrogen to 100 kg ha^{-1} was insufficient, while it was uneconomical to supply more that 300 kg N ha^{-1}. Baghel and Singh (1995) conducted an experiment on cauliflower cv. Pusa Katki and reported that yield increased from 19.53 t ha^{-1} with no fertilizer to 24.98 t ha^{-1} with 80 kg nitrogen. Tesi *et al.* (1996)

conducted a field experiment with two cauliflower cultivars namely SG-118 and Dova. They reported that increasing nitrogen rate increased plant and curd weight but their increase was lower in SG-118 than in Dova. To obtain optimum yields 100 and 200 kg nitrogen /ha^{-1} was necessary for SG-188 and Dova respectively. Burns (1996) reported in cauliflower that the production of curds was lowest when no nitrogen fertilizer was applied, especially when planted at a distance of 75 x 50 cm as compared to 75 x 75 cm. The highest production of curds was obtained with 100 kg nitrogen ha^{-1}. Sanchez *et al.* (1996) conducted an experiment on broccoli and cauliflower and concluded that marketable broccoli and cauliflower yield was increased by water and nitrogen inputs in all experiments. Generalized response equations indicated maximum broccoli yield with 43 cm of water and nitrogen at 267 kg ha^{-1} and maximum cauliflower yields with 65 cm of water and nitrogen at 338 kg ha^{-1}. Burns (1996) while working with hydroponically grown cauliflower concluded that restricting nitrogen supply affected growth and development independently, with the latter being less sensitive to the availability of nitrogen. Reducing nitrogen at curd initiation advanced maturity in cauliflower but at other stages of growth it had little or no effect on the rate of development. Boogard *et al*. (1997) it is shown that nitrogen supply can be reduced to 250 kg/ha without negative effects on yield. An increase in nitrogen supply at 100 kg/ha resulted in 17 kg/ha more residual soil nitrogen, 52 kg/ha more nitrogen in crop residues, 37 kg/ha more mineralizable N and 15 kg/ha more nitrogen in harvested curds. Kaniszewski and Rumpel (1998) reported that nitrogen fertilization up to the rate of 600 kg N/ha increased yield and improved curd quality without delaying harvest time in Poland. Nitrate nitrogen content at the cauliflower plants was positively affected by nitrogen fertilization. At nitrogen rates up to 375 kg N/ha, the NO_3^- -N content in leaves was lower than that in the curd, whereas at higher nitrogen fertilization the opposite relation was observed. Rather *et al*. (1999) field trials were conducted with the cauliflower F_1 hybrid 'Marine', Lindurian' and Limford' at the Ruthe and Schermer sites. Optimum N supply was 250 kg/ha as the sum of the inorganic N content of the soil (N min.) at planting and fertilizer N. The N minimum at planting was 116 and 66 kg/ha at Ruthe and 84 and 20 kg/ha at Schermer.

Effect of plant nutrition : Borna (1971) reported that the highest total and commercial yields from unirrigated and irrigated plots were obtained with 600 and 900 kg/ha NPK (2:2:3), respectively. Fertilization without irrigation resulted in greater yields than vice-versa. Cutcliffe and Munro (1976) observed that the yields were substantially increased at most location by application of nitrogen and phosphorus but were only slightly affected by applied potassium. Maturity was slightly delayed by a lack of P. Maximum yield were generally obtained where N was applied at 112-224 kg/ha, P at 49-98 kg/ha, and Kat 93 kg/ha. Singh *et al*. (1976) observed that significant increased in yield was recorded with the increase in the doses of both the nutrients, except the highest dose of potash. The highest yield was obtained by the maximum dose of nitrogen (120 kg/ha) and Potash (120 kg/ha). Cutcliffe and Munro (1977) found that the highest yields were obtained with 224 kg N and P_2O_5 and 112 K_2O/ha. Crop maturity was hastened by P_2O_5 and 112 K_2O/ha. Nurtika (1979) reported that the highest curd yield was obtained in response to 135 kg N, 200 kg P_2O_5 and 100 kg K_2O/ha. However, the highest yield of marketable plants, and the highest profit, came from treatment with 135 kg N and 100 kg P_2O_5/ha, without potassium. Raut and Kedar (1981) recorded 52.5 tonnes yield /ha by applying of N, P, K at 100, 50 and 50 kg/ha, respectively compared with 33.5 tonnes per ha with 50 kg N, 25 kg P and 25 kg K/ha on podzolic light loamy soil. Roy (1981) found the response to levels of nitrogen was statistically significant. The most economic dose was worked out to be 100 kg of N in combination with 75 kg of P_2O_5 and 50 kg of K_2O per hectare for getting optimum yield of cauliflower at low to medium fertility level of soil. Sharma and Parashar (1982) reported the curd yield increased with increasing levels of water supply and the maximum yield of 18.1 t/ha was obtained under the soil moisture regime 0.25 bar. The interaction of soil moisture regime and N levels and N and P levels were significant. The crop did not respond to P beyond 50 kg P_2O_5/ha in absence of N and vice-vers. Bigelli (1985) obtained highest yield of 26.6 and 26.3 tonnes/ha with 3 tonnes manure + 100 kg N + 120 kg K_2O and 1.5 tonnes manure (applied at hoeing) + 125 kg N + 200 kg K_2O per ha. Politanskaya (1985) observed in peaty podzolic light loamy soils in the USSR, N at 120 or 150 kg/ha with P and K at 60 or 90 kg/ha greatly improved yield and curd quality. Yadav and Paliwal (1990) found the response of cauliflower (Snowball-16) to different levels of nitrogenous (0, 100, 150 and 200 kg N/ha) and phosphatic (0, 50 and 100 kg

P_2O_5 /ha) fertilizers on irrigation with water of low (4 ds m^{-1}) and high 12 ds m^{-1}) salinity. Curd yield was reduced by about 30 per cent with highly saline irrigation water cauliflower responded significantly to increased levels of nitrogen application while addition of phosphatic fertilizer was not found to be beneficial. Swaroop *et al*. (1999) reported that application of N and P favorably increased the average weight of curd, diameter of curd and yield. The maximum average weight of curd (408.5 g), diameter (12.84 cm) and curd yield (64.85 q/ha) were found with the application of 90 kg N and 80 kg P_2O_5 /ha. Moreover N, P application at higher rate i.e. 135 kg N and 120 kg P_2O_5 /ha significantly reduced the diameter as well as yield components. The most effective treatment was 90 kg N+ 80 kg P/ha which increased the average weight of curd, diameter and curd yield over control. Jana and Mukhopadhyay (2001) observed that the application of 150 kg N/ha and 80 kg P_2O_5/ha recorded the highest value with respect to number of leaves per plant, curd diameter, curd depth, net curd weight, curd solidity and marketable curd yield, gave the highest net returns (Rs.37285/ha) and improved the benefit: cost ratio (3.25:1) than other treatment combinations.

Effect of plant population : Khurana *et al*. (1987) study that the highest curd yield was obtained when a spacing of 60 x 40 cm was followed and it decreased with increase in spacing to 60 x 60 and 60 x 80 cm curd leaf ratio and number of leaves per plant were not affected by spacing. Curd yield increased significantly with increase in nitrogen upto 100 kg N/ha. Khurana *et al*. (1990) study to standardize the nitrogen and phosphorus requirement of cauliflower and plant population density. The study revealed that the crop should be applied with nitrogen @ 120 kg N/ha and phosphorus @ 40 kg P_2O_5 /ha to have higher yield of cauliflower. These nutrients improved the curd length and diameter and their appearance. An intra-row spacing of 30 cm yielded significantly higher yield than those spaced at 45 and 60 cm. Tripathi and Sharma (1991) obtained highest yield of cv. Pusa synthetic at a spacing of 30 x 60 cm out of the three competitions i.e. 30 x 60, 45 x 60 and 60 x 60 cm. Singh and Naik (1993) reported that closer spacing of 45 x 30 cm produced the highest number of marketable curds (23.67 and 36.82 per ha^{-1} in 1985 and 1986 respectively) resulted in highest marketable and total yield in cauliflower. Srivastava and Singh (1994) reported that mid season cauliflower to varying spacing (60 x 40, 60 x 60, 60 x 80 cm), nitrogen (0, 50, 100, 150 kg/ha and phosphorus (0, 60, 120 kg P_2sO_5/ha) levels, the plant height, mean per curd weight and net curd yield/ha all increased with increasing level of nitrogen, but there was no response to phosphorus. Generally, the plant spacing also did not influence the plant height but the average curd weight was markedly improved at higher spacing. Patil *et al.* (1995) revealed that the cultivar Kunwari gave highest average curd weight at a spacing of 60x60 cm and highest yield at 45x 45 cm. Chaudhary (2000) found spacing level significantly increased net curd weight, number of leaves/plant, plant height and days to 50 per cent maturity but delayed maturity and reduced curd yield (q/ha). The reduction in curd yield (q/ha) at wider spacing might be due to decrease in plant population. The highest curd yield of 197.6 q/ha was obtained when the planting was done at the spacing of 45 x 45 cm. Singh *et al*. (2004) study revealed that both the cultivars produced significantly higher curd yield under the treatment combination 45 cm x 45 cm spacing and 180 kg N ha^{-1} as compared to other levels. However, line RC-Job-1 was found significantly superior over cultivar Snowball-16.

CONCLUSIONS

Based on above study, it was found that all growth parameters o increased significantly with successive increments in the nutritional doses of (NPK) up to N_{160} P_{120} K_{100} level. Further increase in fertilizer dose did not bring about significant increase in growth characters and reduced number of days to 50 % curd formation and short duration of curd harvesting were observed at $N_{200}P_{150}K_{125}$ levels. However plant population at wider spacing 60 x 60 cm produced significantly higher biological yield, curd diameter, curd depth, net curd weight and marketable curd as compare to closer spacing. Thus, for sustainable production of Indian cauliflower, a plant nutritional dose dose of 160 : 120:100 kg NPK ha^{-1} and spacing of 60 x 45 cm is suitable for higher yield and net return as a result optimum plant population.

REFERENCES

1. Swarup, V. and Chatterjee, S.S. (1972). Origin and genetic improvement of Indian cauliflower. *Eco. Bot.,* **26**: 381-393
2. Dhesi, N.S.; D.S. Padda; J.C. Kumar and Malik, B.S. (1964). Effect of nitrogen, phosphates and potash on the yield of cauliflower. *Punjab Hort. Jour.* **4**(3 & 4): 176.

3. Raziv, I.A. and Jagirder, S.A.P. (1967). Effect of organic manures and ammonium sulphate on cauliflower. *Agri. Pakist.* **18**: 293-298 c.f. *Soil and Ferti.* **32**(4): 32-99.
4. Chaudhuri, B.B. and Yawalkar K.S. (1969). Effect of N, P and K along with farm yard manure on cauliflower. *Hort. Sci.* **1** (1): 33-37.
5. Pimpini, F., F. Venter and Wunsch, A. (1971). The influence of various forms of nitrogen and increasing nitrogen levels on the growth of cauliflower in plot. *Gartenban Wissenschaft* **36**:1-17.
6. Roy, H.K. (1981). Effect of nitrogen on curd size and yield of cauliflower. *Veg. Sci.* **8** (2):75-78.
7. Arora, P.N., Joshi, B.S. and Pande, S.L. (1984). Tips for raising the yield of cauliflower. *Indian Hort.* **15**: 19-20.
8. Markovic, V. Diurovaka, M. (1990). The effect of mineral nutrition on the yield and quality of cauliflower (*Brassica oleracea* var. botrytis L.) *Acta Horti*. **267**; 101-109.
9. Thakur, O.P.; Sharma, P.P. and Singh, K.K. (1991). Effect of nitrogen and phosphorus with and without boron on curd yield and stalk rot incidence in cauliflower (*Brassica oleracea* var. botrytis L.) Veg. Sci. **18** (2): 115-121.
10. Rahn, C.R.; L.V. Vaidyanathan, C.D. Paterson and Scaife, A. (1992). Second congress of the European Society for Agronomy. 2, 424-425.
11. Kotur, S.C. (1993). Relative efficacy of different forms of urea on rainy season cauliflower (*Brassica oleracea* var. *botrytis L.*) and brinjal (*Solanum melongena L.*) on Allisolof Chhotanagpur. *Indian J. Agri. Sci.* **63** (7): 436-439.
12. Yang, X.; Guan, P.C. and Chen, Y.D. (1994). A preliminary study to the relationship between nitrogen and potash nutrition, nitrogen metabolism and yield in cauliflower. *J. south China Agri. Univ.***15** (1): 85-90. Hort. *Abst.* 65 (4) : 887.
13. Fareg, I.A.; Faghali, M.A.; Rafai, E.F. and Shalaby, G.G. (1994). Response of two cultivars of cauliflower to nitrates, boron & molybdenum. *Assiut J. Agril. Sci.* **25** (5): 221-233.
14. Balyan, D. S. and Joginder Singh (1994). Effect Of nitrogen and zinc on production of cauliflower cultivar S-16. *Haryana Agril. Uni. J. Res.* **24** (2/3) 88-92.
15. Baghel, M.S. and Singh, D.B . (1995). Effect of different levels of N, K fertilizers and dates of transplanting on cauliflower (*Brassica oleracea var botrytis* L.).*Recent. Horti.* **2** (2) 84-87.
16. Terata, G.; Poandron, N.; Podolenu, M.; Gavriline, M. and Manteanu, T. (1995). Studies on the effect of nitrogen fertilizers on cabbage and cauliflower. *Anale institutalde cercetari pentra Legumicaltura Si Floricultura, Vidra* **13**: 475-484. (*Hort. Abst.* **67** (2): 1220.
17. Tesi, R. ; Nencini, A.; Bortrini, H. and Graifenbery, A. (1996). Effect of increasing doses of nitrogen on cauliflower. *Rivista di Agronomia.* **30** (2): 174-180. (*Hort. Abst.* 67 (1): 337.
18. Burns, I. G. (1996). Nitrogen supply growth and development *Acta Hort.* No. 428, 21-30.
19. Ssanchez, C.A.; Roth, R.L.; Gardener, B.A. and Ayer, H. (1996). Economic response of broccoli and Report No. 3, Agriculture in India, some facts. Directorate of Agriculture, Jaipur. Rajasthan. Cauliflower to water and nitrogen in the desert. *J. Hort. Sci.* **31**(2): 201-205.
20. Boogaard, R.V.; K.K. Thorup and Vanden, B. R. (1997). Effects of nitrogen fertilization on growth and soil nitrogen depletion in cauliflower. *Soil and Plant Science,* 47: 3, 149-155.
21. Rather, K.; M. Schenk, A.P. Evenaarts and Vethman , S. (1999). Response of yield and quality of cauliflower varieties to nitrogen supply. *J. Hort. Sci. & Biotechnology*, **74** (5): 658-664.
22. Borna, Z. (1971). The effect of high mineral fertilization and irrigation on summer cauliflower yield. *Roczniki Wyzszej-Szkoly-Roluiezej-w-Poznaniu* (50): 11-18.
23. Cutcliffe, J.A. and Munro D.C. (1976). Effects of nitrogen, phosphorus and potassium on yield and maturity of cauliflower. *Canadian J. Plant. Sci*. **56** (1): 127-131.
24. Singh, R.D.; S.N. Tiwari, B.B. Singh and Seth, J.N. (1976). Effect of nitrogen and potash on growth and curd yield of cauliflower var. Snowball-16. *Prog. Hort.* **7** (4): 29-34.
25. Cutcliffe, J. A. and Munro, D. C. (1977). Fertilizers for maximum production at cauliflowers. *Canada Agriculture*, **22** (2): 5.
26. Nurtika, N. (1979). The effect of NPK levels on cauliflower yield. Buletin-penelitian Hortiultura. 7 (8): 15-18.
27. Raut, K.R and Kedar, V.P. (1981). Effect of fertilizer levels and plant growth regulators on the growth and yield of cauliflower. *Mah Coll. Of Agril. Nagpur,* **53**: 73-75
28. Roy, H. K. (1981). Effect of nitrogen on curd size and yield of cauliflower. *Veg. Sci.* **8** (2): 75-78
29. Sharma, R.P. and Parashar, K.S. (1982). Response of cauliflower to soil moisture regimes, nitrogen and phosphorus levels. *Veg. Sci.* **9** (2): 75-81
30. Yadav, B. R. and Paliwal, K.V. (1990). Response of cauliflower (*Brassica oleracea* var. botrytis L.) to nitrogen and phosphorus fertilizer on irrigation with saline water. *Veg. Sci.* **17** (1): 1-6
31. Swaroop, K.; M. A. Suryanayanan and Sharma , T. V. R. S. (1999). Effect of nitrogen and phosphorus on growth and curd yield at cauliflower. *Veg. Sci.* **26** (1): 85-86.
32. NHB Database (2005). Production year book. *National Horticultural Board,* Gurgaon, *Haryana.*
33. Khurana, S. C., Singh, G. R. and Pandita, M. L. (1987). A note on nitrogen, phosphorus fertilization and spacing on cauliflower cv. Pusa synthetic. *Haryana j. Hort. Sci.* **16** (3-4): 298-3
34. Khurana, D. S.; Harjit Singh; Jarnail Singh and Cheema, D. S. (1990). Effect of N, P and plant population on

yield and its components in cauliflower. *Indian J. Hort.* **47** (1): 70-74.

35. Tripathi, P. K. and Sharma, R. K. (1991). Studies on the effect of age of seedlings and spacing on the growth and yield of cauliflower. *New Agriculturist.* **1** (2): 177-182.

36. Singh, R. V. and Naik, L. B. (1993). Response of cauliflower (cv. Early Kunwari) to plant to plant density, nitrogen and phosphorus levels. *Prog. Hort.* **22** (1-4): 160-163

37. Srivastava, B. K. and Singh, M. P. (1994). Effect of spacing, nitrogen and phosphorus on performance of mid season cauliflower. *Indian J. Hort.* **51** (2): 187-191.

38. Patil, J.D.; Ranpise, S. A. and Jadhav, S. B. (1995). Effect of spacing and date of seed sowing on yield of different cultivars of cauliflower. *Madras Agric. J.* **82** (11): 613-614.

39. Chaudhary, D.R. (2000) curd yield of mid season cauliflower as influenced by date of planting and plant density. H*aryana J. Hort. Sci***.** **28** (1 & 2): 106-107.

40. Singh, K.; R. S. Dhaka and Fageria, M. S. (2004). Response of cauliflower cultivars to row spacing and nitrogen fertilization. *Progressive Hort.* **36** (1): 171-173.