INFLUENCE OF SPACING AND PHOSPHORUS ON GROWTH AND FLOWERING OF COCKSCOMB

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INFLUENCE OF SPACING AND PHOSPHORUS ON GROWTH AND FLOWERING OF COCKSCOMB

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CERTIFICATE

This is to certify that the thesis entitled **“Influence of spacing and phosphorus on growth and flowering of cockscomb”** submitted to the Department of Horticulture, Sher-e-Bangla agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE,** embodies the result of a piece of *bona fide* research work carried out by **MD. MAZEDUL ISLAM,** Registration Number: **06-1988** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has been duly acknowledged.

Dated: June, 2013
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ABSTRACT

The experiment was conducted at the Horticultural Farm, Sher-e-Bangla Agricultural University, Dhaka, during the period from March 2012 to May 2012. The experiment consisted with two factors, such as factor-A: three levels of plant spacing; S_1: 35×20 cm, S_2: 35×25 cm and S_3: 35×30 cm and three levels of phosphorus; P_o: 0 kg, P_1: 50 kg and P_2: 100 kg P_2O_5/ha respectively. The experiment was set up in a Randomized Completely Block Design with three replications. Spacing and phosphorus fertilizer significantly influence on most of the parameters. In case of spacing, highest number of spike (126,582/ha) was obtained from S_2 and the lowest (25,316/ha) from S_3. For phosphorus, highest number of spike (101,265/ha) was obtained from P_1 and the lowest (20,320/ha) from P_o. For combined effect, highest number of spike (132,531/ha) was obtained from S_2P_1 and the lowest (27,260/ha) from S_3P_o treatment. So, 35×25 cm spacing with 50 kg P_2O_5/ha is found best for growth and flowering of cockscomb.

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LIST OF ABBRIVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
et al.	and others
^{o}C	Degree Celsius
DAT	Days After Transplanting
FAO	Food and Agriculture Organization of United Nations
g	Gram
Kg	Kilo Gram
M	Meter
cm	Centimeter
MoP	Muriate of Potash
%	Percentage
RCBD	Randomized Completely Block Design
m^2	Square meter
TSP	Triple Super Phosphate
UNDP	United Nations Development Program
LSD	Least Significance Difference
CV	Co-efficient of variance
ha	Hectare
BARI	Bangladesh Agricultural Research Institute

INTRODUCTION

Cockscomb ***(****Celosia cristata* L.*)* belongs to the family Amaranthaceae, is one of the most eye-catching dwarf annual bedding flowers of summer (Neora, 1995). There are three types of Celosia which are easily distinguishable from each other. They are plumes, crests and cones. Most common colors are dazzling red, yellow, cream, orange, rose, deep magenta and pink. The flowers are good for cutting and can be dried for table decoration as the dried flower heads retain the colors for a long time (Randhawa, 1986). Celosia can range in size from dwarf varieties that only grow four to six inches high to vigorous types over three feet tall. Taller varieties are excellent cut flower

The exact geographic origins of celosia in the world are unknown, although speculations include the dry slopes of Africa and India as well as dry stony regions of both North and South America. In early 17th century it was distributed in different part of the world.

Cockscomb is particularly popular for their use as an excellent bedding flower (Chanda *et al.,* 1999). They are also used as cut flower, dried flower and indoor planting in pots. Chinese herbalists used it to stop bleeding, treat diseases of the blood and infections of the urinary tract. Their leaf, flower are often used as vegetables.

In Bangladesh it is a common garden flower but commercial cultivation is rare. But it has potential prospect of production commercially as well as to beautify public and private places. Most of the bedding flowers grow well in winter but summer is bare of stout bedding flowers except some weak varieties in Bangladesh. During summer there is shortage of stress resistant colored bedding flower except cockscomb. So, Cockscomb can play an important role to minimize the scarcity of summer bedding flower to beautify public and private places.

Plant spacing is one of the factors that can be manipulated by farmers or growers to increase the production of the crop. Plant density plays an important role in vegetative growth of plant and yield of crops (Bansal, *et al*., 1995 and Misra *et al*., 1985). Spacing of the plant influences on the growth of Amaranthus. Higher plant population may compensate the lower individual plant yield. Substantial works on plant spacing were done with different flowers home and abroad. But information regarding the plant spacing of Cockscomb flower is scanty (Bansal *et al*., 1995 and Misra *et al*., 1985). David *et al.* (1994) conducted an experiment on plant spacing (0.3 m, 0.6 m and 0.9 m) on the growth, yield and mineral composition of vegetable cockscomb. They observed that root and shoot fresh weight per plant and stem diameter increased as plant spacing increased whereas plant residue and marketable yield per hectare increased as plant spacing decreased. Leaf 'Ca' increased as plant spacing increased before seed head formation, whereas leaf P, K and Ca similarly increased after seed head formation.

Phosphorus is an essential macro-nutrient that is required to meet global food requirements and make crop and livestock production profitable (Sharpley and Lunncy, 2000). Plant cells need to have adequate phosphorus before they divide. Additionally, phosphorus increases root growth, grain, fiber and forage yield, enhances early plant maturity and stalk strength and promotes resistance to root for disease and winter kill *(*Norfleet, 1998). Nitrogen and phosphorus fertilizers influence on the plant growth and flower quality as well as yield (Rabbani *et al*., 2005). Phosphorus is an important for the plants in order to store energy and plays a role in fruit development. It is often present in adequate amounts for perfect Cockscomb growth but much of it is not readily available to the plants because it gets tied up in both the mineral and organic fraction of the soil. As a fertilizer, it becomes available to the plants slowly and should be worked into the soil prior to planting to improve its uptake. Duang Lingdon *et al.* (1975) conducted an experiment on influence on phosphorus on color stability of cockscomb during the life cycle. Phosphorus doze was 0 kg/ha, 50 kg/ha and 100 kg/ha on color retention and alive condition of cockscomb showed significant relationship.

Most of the soils and climatic conditions of Bangladesh are suitable for Cockscomb production. There is scope for increasing yield of this flower by using suitable spacing and phosphorus with other fertilizers under the agro-ecological condition in Bangladesh. However, research works on spacing and phosphorus management for Cockscomb is not available in Bangladesh.

Considering the above mentioned facts the present study was undertaken and designed with the following objectives.

i. To find out the suitable plant spacing for proper growth and yield of Cockscomb,
ii. To find out the suitable dose of phosphorus for growing of Cockscomb and
iii. To find out the best combination of spacing and phosphorus for ensuring the higher growth and yield.

REVIEW OF LITERATURE

The available and easily cultivated cockscomb is amigo-mix celosia which is colored bedding flower in summer season. Information on the works of the influence of spacing and phosphorus on the growth and yield of cockscomb is meager. Some of the works related to the present study have been presented below.

2.1 Literature on plant spacing

Igbo *et al*. (2000) conducted an experiment to find out the effect of spacing on stem amaranth. Plant spacing (0.3 m, 0.6 m and 0.9 m) on the growth, yield and mineral composition of vegetable amaranth *(Amaranthus cruentus* L*)*. They observed that root and shoot fresh weight per plant and stem diameter increased as plant spacing increased whereas plant residue and marketable yield per hectare increased as plant spacing decreased. Leaf 'Ca' increased as plant spacing increased before seed head formation, whereas leaf P, K and Ca similarly increased after seed head formation.

Peiretti *et al.*(1998) studied the effect of inter row spacing on growth and yield of amaranths with four different row spacing 20 cm, 45 cm, 60 cm and 70 cm. Both the vegetative characters assessed at the beginning of the inflorescence state and noticed that seed yield per plant at harvest decreased with closer row spacing. Yield, however, was only affected on tender with increase in density.

Baskar *et al.* (1996) conducted an experiment to determine the effect of plant population on yield of grain amaranth. They reported that a local variety of amaranths grown at densities of 111000, 148000 or 222000 plants/ha produced seed yield of 466, 467 and 553 kg/ha, respectively.

Haradecka *et al*. (1994) carried out an experiment to study the effect of sowing rates on the production parameters of the "K 343" amaranth. No significant differences in the leaf area index were recorded between stands sown at the rates of 16 and 65 plants/m^2. At the former sowing rate, the LAI was 3.6 m^2m^{-2}, at the latter it was 3.2 m^2m^{-2}. There were considerable differences in the number and size of leaves. Increased branching in the thin stand also influenced the proportion of leaves and stems in different organs during the growing season.

Henderson *et al.*(1993) studied effect of row spacing and population on yield of grain amaranth. Population of 74000, 172000 and 272000 plants/ha at row 20.5 cm and wide 76.2 cm row spacing. Stands were over sown and thinned by hand to achieve the desired population. They observed that the highest yields were obtained with the lowest population. Row spacing had on effect on yield at the lowest plant population but yields been higher at widest spacing with the 2 times higher as a result of the lower plant population in the wider rows.

Shongwe *et al.* (1993) conducted two field experiments with the cultivar Monogoof amaranth were on a sandy clay loam soil during the summer growing seasons of 1990-91 and 1991- 92, Seeds were sown in drills on 8 October and 2 September, respectively and transplanted 4 weeks later. In the first experiment, 4 spacing (64 cm × 45 cm, 60 cm × 60 cm, 90 cm × 45 cm and 90 cm × 60 cm) and 2 topping treatments (2 and 5 weeks after planting) were compared. In the second, 5 spacing (45 cm × 45cm, 60 cm × 60 cm, 90 cm × 45 cm and 90 cm × 60 cm), 3 cutting height (10 cm, 15 cm and 20 cm) were compared. Early topping, 2 weeks after planting reduced both the total yield and the leaf: stem ratio. The closest spacing 45 cm × 45 cm, which produced the maximum total yield/plant gave the highest total yield/ha whereas the converse was observed with the widest spacing 90 cm × 60 cm. There was no significant improvement in shoot leaf or stem quality with any of the spacing tested. The 3 cutting heights did not influence total shoot and stem yield. However the total leaf yields and leaf: steam ratio were greater with cutting height of 15 and 20 cm than 10 cm.

Harvesting at 2 weeks intervals gave higher total shoot and leaf yields and a greater leaf stem ratio than did harvesting at 3 weeks intervals.

Paul *et al.* (1992) studied effect of spacing, nitrogen and pinching on globe amaranth *(Gompherna globosa)*. The effect of 3 of N (0, 100, 200 Kg/ha) and pinching vs. non-pinching were compared and observed that plant with number of branches/plant and number, weight of flowers/plant increased significantly with under spacing. They also found that plant increased significantly with under spacing. However, the flower yield/plant area was greatest with a spacing of 20 cm × 20 cm.

Mortley *et al.* (1992) conducted an experiment to the plant spacing influences yield within rows growth and yield of *Amaranth sp.* was studied during the summer of 1991. Spacing was 10, 20, 20 or 40 cm corresponding to approx. 161000, 80000, 54000, and 40000 plants/ha, respectively. Plants were harvested 4 times over 3 months and fresh weight yield on per plant and per unit area bases were determined. Measurement of stem diameter was carried out 2 weeks after transplanting and continued up to the first harvest. They observed that the fresh weight yield/plant increased linearly at from 10 to 40 cm and with each harvest up to the third but it declined at the fourth harvest. Total FW yield/plant across all 4 harvests increased linearly per harvest and across all harvest as spacing between vegetable amaranth can be grown successfully in Alabama harvested more than once and that FW yields are highest at close spacing.

2.2. Literature on phosphorus

Ahmmed *et al.* (2011) observed that influence of Phosphorus (0, 60, 80, 100 kg P_2O_5/fed and Zinc (0, 5, 15, 25 Kg/fed) on vegetative growth, yield and fruit quality of strawberry plants. The result indicated that, vegetative growth character (no. of leaves, no. of runners, leaf area, foliage fresh mass and dry mass/plant) and flowering traits (no. of flower clusters/plant and earliness) were significantly increased with the high rates of P and Zn. Early yield, marketable yield, total yield and yield/plant, generally seemed to be increased with the high rates of P and Zn. The highest mean values of average fruit weight, fruit length, fruit diameter, fruit juice content, TSS and vitamin C were figured out for plants supplied with P and Zn at the highest levels. The interaction between P and Zn reflected positive effects on all studied quantitative and qualitative characters of strawberry plants.

R. Tania (2005) conducted an experiment at the Central Farm of Shcr-e-Bangla Agricultural University, Dhaka during the period of April to June, 2005 to study the effects of four levels of phosphorus (P_2O_5) viz., control treatment (no phosphorus), P_1 (43.2 kg/ha), P_2 (48 kg /ha) and P_3 (52.8 kg /ha) and four levels of potassium (K_2O) viz., control treatment (no potassium), K_1 (114 kg /ha), K_2 (120 kg/ha) and K_3 (126kg/ha) on the growth and yield of stem amaranth. The two factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Most of the growth and yield parameters were significantly influenced by both phosphorus and potassium at 45 DAS. The maximum plant height (87.99 cm), plant diameter (2.43 cm), green yield per plant (285.54g) and green yield per hectare (45.70t) were observed in the treatment of phosphorus applied at 48 kg/ha at 45 DAS. The minimum plant height (78.17 cm), plant diameter (1.50 cm), green yield per plant (187.27g) and green yield per hectare (30.00t) were obtained from the control treatment at 45 DAS. The maximum plant height (87.49 cm), plant diameter (2.70 cm), green yield per plant (285.0g) and green yield per hectare (45.60t) were found from the plot receiving 120 kg K/ha at 45 DAS, while the control treatment gave the lowest plant height (78.51 cm), plant diameter (1.52 cm), green yield per plant (189.18g) and green yield per hectare (30.30t).

Among the treatment combinations P_2K_2 (48kg P + 120 kg K/ha) gave the highest plant height (92.47cm), plant diameter (3.00 cm), green yield per plant (326.40g) and green yield per hectare (52.22t) at 45 DAS. The lowest plant height (48.47 cm), plant diameter (1.50 cm), green yield per plant (187.14g) and green yield per hectare (29.94t) were recorded from the control treatment.

Vance, (2001) and Bieleski, (1973) conducted a research and found that phosphorus is recognized as an important mineral element limiting crop growth and production. It is generally considered as the second most limiting nutrient after nitrogen (N) for plant growth. The acid-weathered soils of the tropics and subtropics are particularly prone to phosphorus deficiency and Al toxicity (Von Uexkull and Mutert, 1995).

Alsaeedi *et al*. 2000 presented that plants suffering from P-deficiency showed retarded growth and low shoot/root dry matter ratio. Phosphorus, an important nutrient for propagation, vigor and general health of all plants, is often referred to as the ‘energizer’ because it helps store and transfer energy within plants during photosynthesis process (Busman *et al.* 1998; Schachtman, 1998).

Parfitt *et al*. 1973 showed that P-deficiency affected the development of reproductive organs and decreased number of flowers. The formation of fruits and seeds is especially depressed in plants subjected to P-deficiency. The available P in Bangladeshi soil could be considered to be between low and medium. About 20.70% areas were reported to be predominantly low in available P and 21.20% were medium in available P which is limiting crop production. Therefore, one of the adverse effects in agriculture practice in Bangladesh is P deficiency. Plants cannot live at phosphorus concentration below two parts per ten million in soil solution. Knowledge of crop N and P requirements is essential in developing profitable nutrient management planning to meet plant needs for producing high quality crops (Gastal and LEmaire, 2002; Li *et al*., 2006; Li *et al.,* 2009a). Selecting cultivars efficient in nutrient use could be an option for producing high quality crops (Li *et al*., 2009b).

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in conducting of the experiment.

3.1 Experimental Site

The experiment was conducted at Horticulture farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka Bangladesh during the period from March, 2012 to May, 2012. The location of the site is at 23.774^0 N latitude and 90.335^0 E longitude with an elevation of 8.2m from sea level (BBS, 2009). The experimental field was medium high land belonging to the chhiata series of Grey Terrace Soil under the AEZ-28, Madhupur Tract (SRDI, 2010). The morphological characteristics of the land are presented in Appendix IA and the physical and chemical characteristics of the soil are presented in Appendix IB.

3.2 Climate

The experimental field is under subtropical climate characterized by heavy rainfall during the month of April to September and scanty rainfall during October to March (SPARSO, 2010). The monthly means of daily maximum, minimum and average temperature, relative humidity, total rainfall and sunshine hours received at the experimental site during the period from March, 2012 to May, 2012 are presented in Appendix II.

3.3 Soil

The soil of the experimental area was non-calcareous dark grey and belongs to the Madhupur Tract under AEZ 28. The selected plot was medium high land and soil series was Tejgoan (FAO, 1988) with a pH of 5.6. The analytical data of the soil sample collected from the experimental area were analyzed in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka and details of the soil characteristics are presented in Appendix IB.

3.4 Land preparation

The land was first opened by ploughing in the month of March, 2012 with the help of power tiller and then it kept open to sun for seven days prior to further ploughing. Afterwards it was prepared by ploughing and cross ploughing followed by laddering. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made into good tilt. The basal doses of manures and fertilizers were applied during final land preparation.

3.5 Treatment (s) of the experiment

The experiment was designed to study the effect of phosphorus and plant spacing on growth and yield of Cockscomb.

The experiment consisted of two factors, which are as follows:

Factor A: Spacing

S_1= Wider spacing (35 X 30 cm)

S_2= Medium spacing (35 X 25 cm)

S_3= Close spacing (35 X 20 cm)

Factor B: Phosphorus

P_0= Control (Without P_2O_5)

P_1= 50 kg P_2O_5/ha

P_2= 100 kg P_2O_5/ha

There were altogether 9 treatment combinations such as: S_1P_0, S_2P_0, S_3P_0, S_1P_1, S_2P_1, S_3P_1, S_1P_2, S_2P_2 and S_3P_2.

3.6 Design and layout of the experiment

The two factors experiment was laid out in Randomized Completely Block Design (RCBD) with 3 replications. Each block was divided into 9 plots, where treatments were allotted at random. Thus, there were 27 unit plots altogether in the experiment. The size of plot was 1.5 m ×1.05 m. The distance between blocks 0.5 m and 0.5 m wide drains was made between the plots. Every unit plot had 3 rows with 27 plants each.

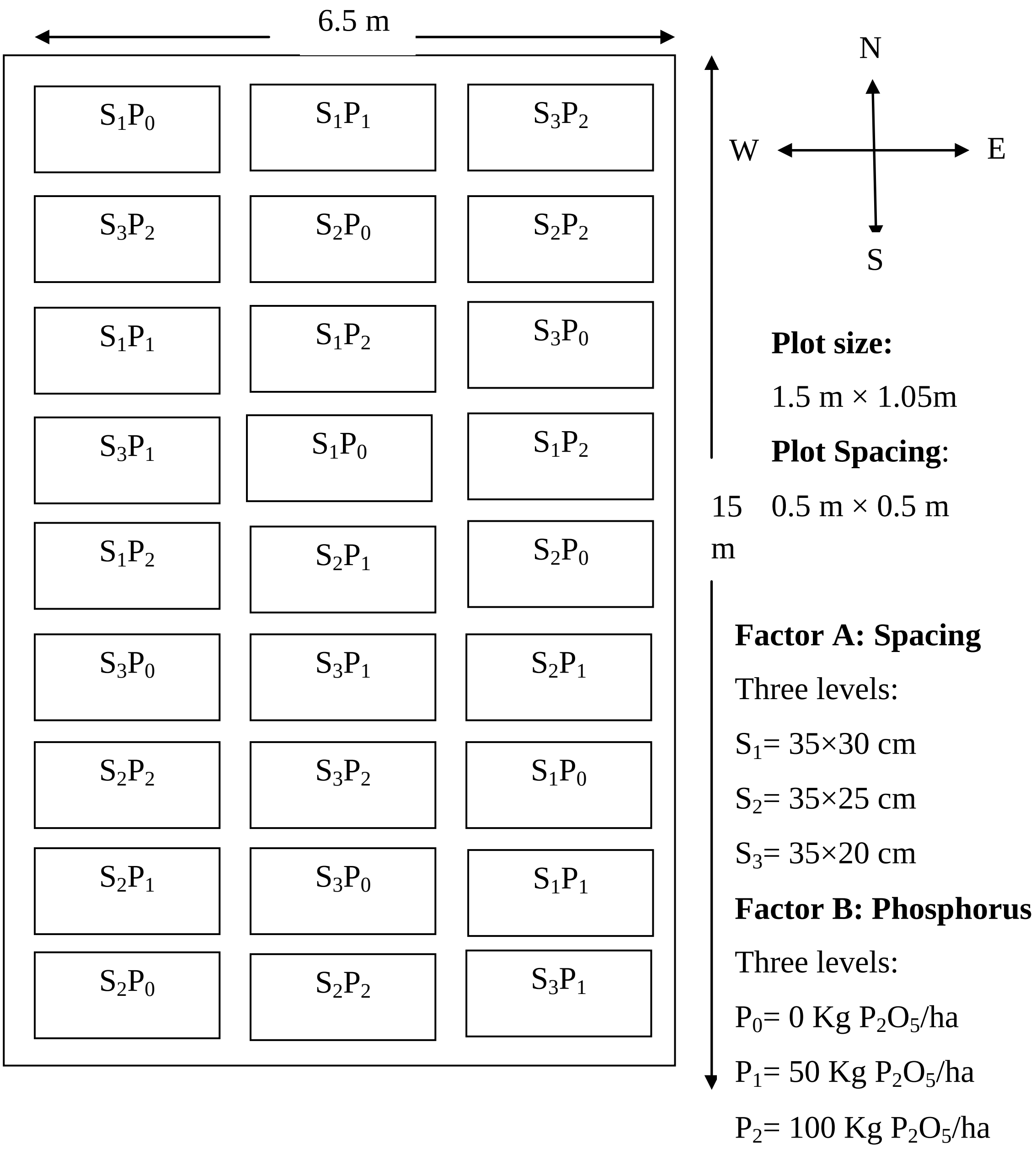

Fig 1: Layout of experimental field

3.7 Production Method

3.7.1. Collection of materials

Seed of amigo-mix cockscomb was collected from KRISHIBID NURSERY, Agargaon, Dhaka-1207 on the month of February, 2012. Single packet of cockscomb contained thousand seeds.

3.7.2 Seedbed Preparation

Standard seed bed was prepared on 15 February, 2012 allowing the size of 3m x 1m. Cockscomb seed was sown on 19 February, 2012 by broadcasting method. Frequently irrigation was done up to emergence of seedling.

Plate-1: Seedbed of Cockscomb

3.7.3 Fertilizer application to the main field

Cowdung, urea and MoP were applied at the rate of 10 ton, 150 Kg and 100 Kg per hectare respectively. The source of applied P_2O_5 was TSP. The total amount of cow dung and MoP was applied at the time of land preparation. The rest of Urea was applied at 10 DAT. TSP was applied with the basal doze at three different levels according to experimental design as treatment.

3.7.4 Transplanting of seedlings

Plantlet at the height of 2.5-5.0 cm was transplanted to the main field in the afternoon considering preconized spacing. Twelve (12) plants were transplanted in each plot.

3.7.5 Irrigation and drainage

Light over-head irrigation was provided with a watering can to the seedbed and immediately after transplanting of cockscomb seedlings to main plots.

3.7.6 Weeding

Weeding was done in all the plots as required to keep the plot free from weeds, easy aeration of soil which ultimately ensured better growth and development. Breaking of crust of the soil was done when needed.

3.7.7 Protection

Sevin powder and Bavistin 50 WP was sprayed to protect the field from black ant, termites and leaf spot disease at 10 days after transplanting (DAT).

3.8 Data collection

Harvesting was started on 20 May, 2012. Data were collected on the following parameters:

3.8.1 Plant height

The plant height was measured from the attachment of the ground level up to the tip of the growing point. Plant height was recorded in centimeter (cm) from five randomly selected plants at 20, 30 and 40 days after transplanting (DAT) by using scale and mean was calculated.

3.8.2 Stem height

The stem height was measured from the attachment of the ground level up to lower level of the growing point. Stem height was recorded in centimeter (cm) from five randomly selected plants at 20, 30 and 40 days after transplanting (DAT) by using scale and mean was calculated.

3.8.3 Number of leaves per plant

Number of leaves per plant was counted and data were recorded from randomly selected five plants at 20, 30 and 40 days after transplanting (DAT) and mean was calculated.

3.8.4 Diameter of crown

Diameter of crown was recorded in centimeter (cm) and data were recorded from randomly selected five plants at 20, 30 and 40 days after transplanting (DAT) and mean was calculated.

3.8.5 Dry weight of plant

The dry weight of plant was recorded after electric oven drying of the cockscomb plant entirely. Dry weight of plant was recorded in gram (g) from two randomly selected plants at 20, 30 and 40 days after transplanting (DAT) by using electric balance and mean was calculated.

3.8.6 Breadth of the tip of spike

The spike tip of the cockscomb is wide, fleshy, crested, deep colored and similar to conical shape. Tip breadth was measured from the base of the spike and up to the tip of the spike. Spike length was recorded in centimeter (cm) from five randomly selected plants at 20, 30 and 40 days after transplanting (DAT) by using scale and mean was calculated.

3.8.7 Dry weight of spike

The dry weight of spike was recorded after electric oven drying of the cocks' comb after separating by knife cutting at the basal point of the stalk. Dry weight of spike was recorded in gram (g) from two randomly selected plants at 20, 30 and 40 days after transplanting (DAT) by using electric balance and mean was calculated.

3.8.8 Number of first initiated flower

Number of first initiated flower was counted and data were recorded from randomly selected nine plants at 20 days after transplanting (DAT) and mean was calculated.

3.8.9 Number of 80% emergence flower

Number of 80% initiated flower was counted and data were recorded. Nine plants per plot were in consideration during calculation at 30 days after transplanting (DAT) and percentage was converted.

3.8.10 Duration of senescence of 80% flower

Duration of senescence of 80% flower was counted in the form of day and data were recorded from nine plants per plot and percentage was calculated.

3.8.11 Number of spike per plot

Number of spikes per plant was counted and data were recorded from randomly selected five plants at 20, 30 and 40 days after transplanting (DAT) and mean was calculated.

3.8.12 Statistical analysis

Collected data for various characteristics were statistically analyzed using MSTAT-C program. Mean value for all the spacing and phosphorus treatments were compared by analysis of variance. Difference among treatments was evaluated by Least Significant difference (LSD) (Gomez and Gomez, 1984).

RESULT AND DISCUSSION

Present experiment was conducted to determine the effect of spacing and phosphorus on the growth and yield of cockscomb and result have been presented and discussed in this chapter. Some of the data have been expressed in table(s) and others in figure(s) for each of discussion, comprehension and understanding. A summary of the analysis of variances in respect of all the parameters have been shown in appendices. Results are presented and discussed under the following headings:

4.1 Plant height

Significant difference in plant height was found due to variation of plant spacing (Appendix III). There was gradual increasing trend of plant height (Fig. 2) at 20, 30 and 40 DAT. The highest plant height (24.2 cm) was obtained from medium spacing (S_2) and lowest plant height (19.7 cm) was obtained from the lowest spacing (S_3) at 40 DAT. This was due to decreasing of plant spacing competition on nutrient, light and moisture mounted up and plant height affected. But in optimum spacing plant height showed the best performance. However there was no significant variation in term of plant height between S_1 (30 cm) and S_3 (20 cm) treated plant at 40 DAT (Fig. 2)

Plant height of Cockscomb showed significant differences due to application of phosphorus (Appendix III). Fig. 3 represents a gradual increasing trend of plant height with days after transplanting for different doses of phosphorus application. The tallest plant (23.8 cm) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the smallest plant (19.7 cm) was found in P_2 treatment (100 Kg P_2O_5/ha) at 40 DAT. Plant height was the lowest where there was no phosphorus applied to bed. With the increasing doze of phosphorus plant height of cockscomb increased but after a certain level it decreased. Because excessive doze of phosphorus caused toxic condition and plant growth was hampered.

However, there was significant variation in term of plant height between P_0 (control) (21.8 cm) and P_2 (19.7 cm) treated plant at 40 DAT. (Fig. 3)

Significant difference was observed due to the combined effect of spacing and phosphorus on plant height at 20, 30 and 40 DAT (Appendix III). It was observed that tallest (26.9 cm) plant was produced by S_2P_1 and shortest plant (17.8 cm) was obtained from S_3P_2 treatment at 40 DAT (Table 1).

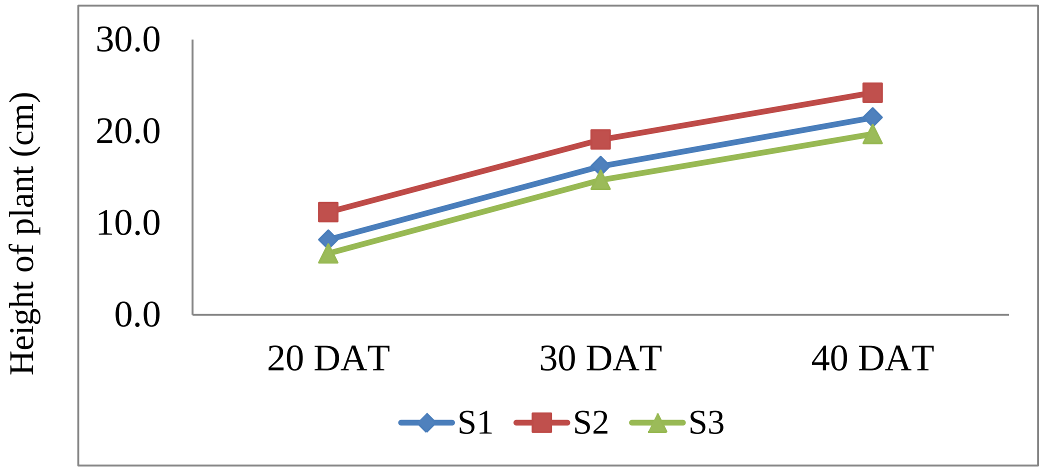

Fig. 2: Effect of plant spacing on height of plant at different days after transplanting (DAT)

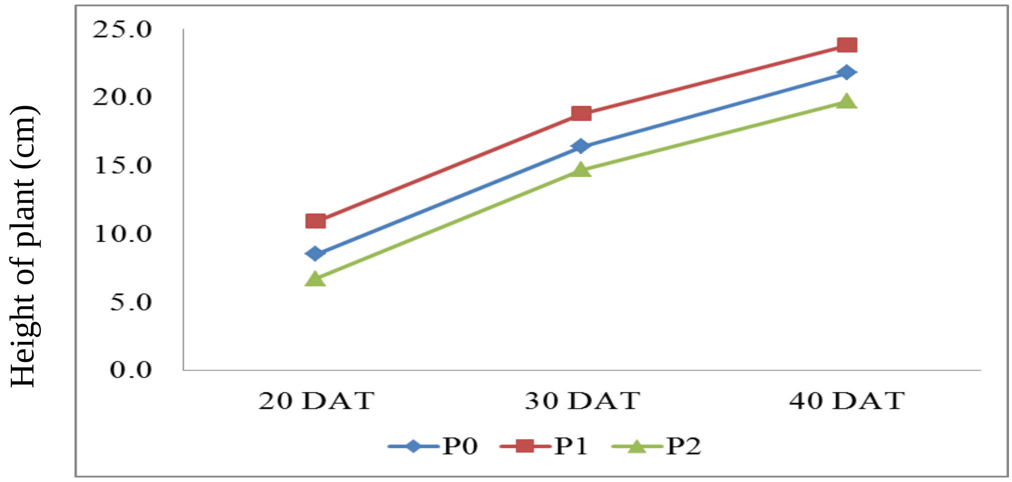

Fig. 3: Effect of Phosphorus on height of plant at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-1: Combined effect of spacing and phosphorus on the growth of Cockscomb at different days after transplanting (DAT)

Height of plant (cm)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	7.40 cde	15.40 cde	21.40 bcd
S_1P_1	10.30 bc	18.30 bc	23.30 bc
S_1P_2	6.70 de	14.80 de	19.80 de
S_2P_0	10.10 ab	15.00 ab	18.00 ab
S_2P_1	13.90 a	21.90 a	26.90 a
S_2P_2	8.60 bcd	16.60 bcd	21.70 bcd
S_3P_0	6.90 cde	15.00 cde	20.00 cde
S_3P_1	8.30 bcd	16.30 bcd	21.30 bcd
S_3P_2	4.80 e	12.80 e	17.80 e
$LSD_{(0.05)}$	3.44	3.39	3.36
CV(%)	2.88	1.77	4.89

4.2 Stem height

Significant difference in stem height was found due to variation of plant spacing (Appendix IV). There was gradual increasing trend of stem height (Fig. 4) at 20, 30 and 40 DAT. The highest stem height (16.6 cm) was obtained from medium spacing (S_2) and lowest stem height (12.1 cm) was obtained from the lowest spacing (S_3) at 40 DAT. This was due to decreasing of plant spacing competition on nutrient, light and moisture mounted up and stem height affected. But in optimum spacing stem height showed the best performance. However, there was no significant variation in term of stem height between S_1 (20 cm) and S_3 (30 cm) treated plant at 40 DAT (Fig. 4)

Stem height of Cockscomb showed significant differences due to application of phosphorus (Appendix IV). Fig. 5 represents a gradual increasing trend of stem height with days after transplanting for different doses of phosphorus application. The tallest stem (16.2 cm) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the smallest stem (12.1 cm) was found in P_2 treatment (100 Kg P_2O_5/ha) at 40 DAT. Stem height was the lowest where there was the highest phosphorus applied to bed.

Because with the increasing doze of phosphorus plant height of cockscomb increased but after a certain level it decreased even it showed the lowest effect. Because excessive doze of phosphorus caused toxic condition and plant growth was hampered. So there was no significant variation in term of stem height between P_0 (control) (10.0 cm) and P_2 (12.1 cm) treated plant at 40 DAT. (Fig. 5)

Significant difference was observed due to the combined effect of spacing and phosphorus on stem height at 20, 30 and 40 DAT (Appendix IV). It was observed that tallest (19.2 cm) stem was produced by S_2P_1 and shortest plant (10.2 cm) was obtained from S_3P_2 treatment at 40 DAT (Table 2). So the combination of the best spacing and the best phosphorus level showed the best performance in stem height of cockscomb.

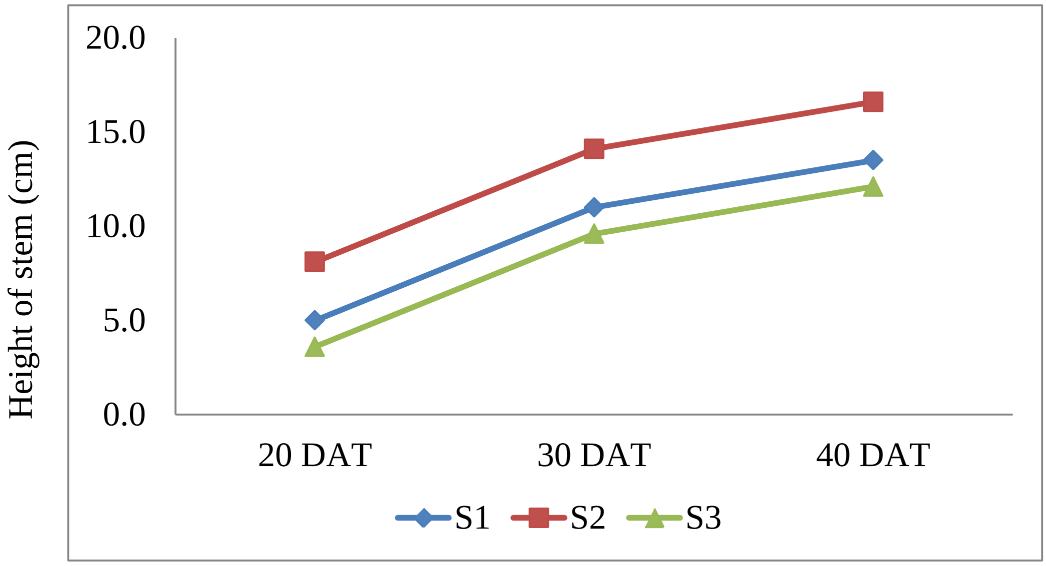

Fig. 4: Effect of spacing on the height of stem at different days after transplanting (DAT)

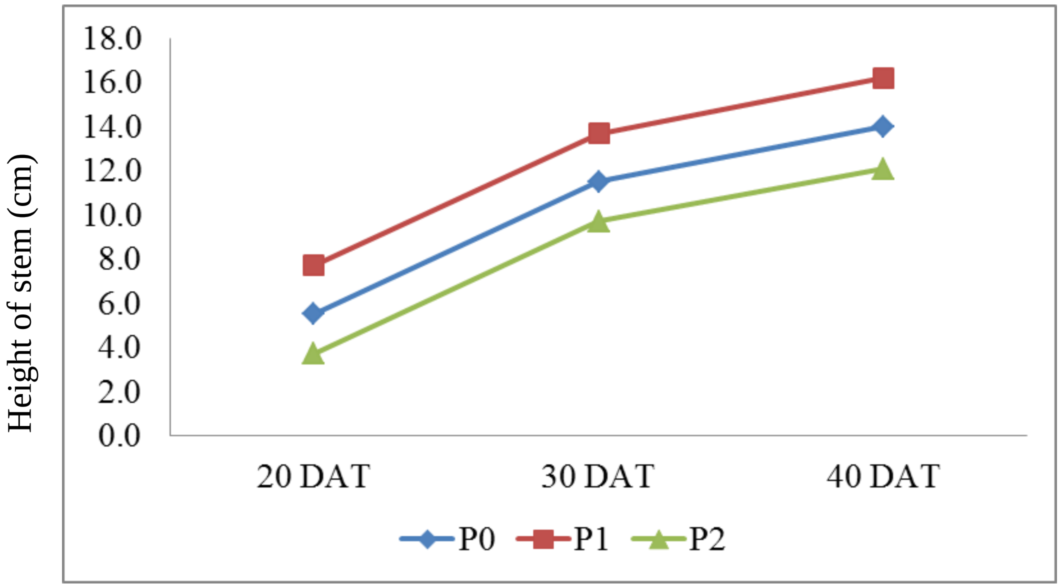

Fig. 5: Effect of Phosphorus on the height of stem at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-2: Combined effect of spacing and phosphorus on the growth of Cockscomb at different days after transplanting (DAT)

Height of stem (cm)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	4.40 cd	10.50 cd	13.00 cd
S_1P_1	6.90 bc	12.90 bc	15.40 bc
S_1P_2	3.70 cd	9.70 cd	12.20 cd
S_2P_0	8.10 ab	14.10 ab	16.60 ab
S_2P_1	10.70 a	16.70 a	19.20 a
S_2P_2	5.60 bc	11.60 b	14.10 bc
S_3P_0	3.90cd	9.90 cd	12.40 cd
S_3P_1	5.40 bc	11.40 bc	13.90 bc
S_3P_2	1.60 d	7.70 d	10.20 d
$LSD_{(0.05)}$	3.49	3.47	2.00
CV(%)	5.94	7.24	4.19

4.3 Leaf number

Significant difference in leaf number was found due to variation of plant spacing (Appendix V). There was gradual increasing trend of leaf number (Fig. 6) at 20, 30 and 40 DAT. The highest leaf number (13) was obtained from medium spacing (S_2) and lowest leaf number (9) was obtained from the lowest spacing (S_3) at 40 DAT. This was due to decreasing of plant spacing competition on nutrient, light and moisture mounted up and number of leaf affected. But in optimum spacing leaf number showed the best performance. However, there was no significant variation in term of leaf number between S_1 (30 cm) and S_3 (20 cm) treated plant at 40 DAT (Fig. 6)

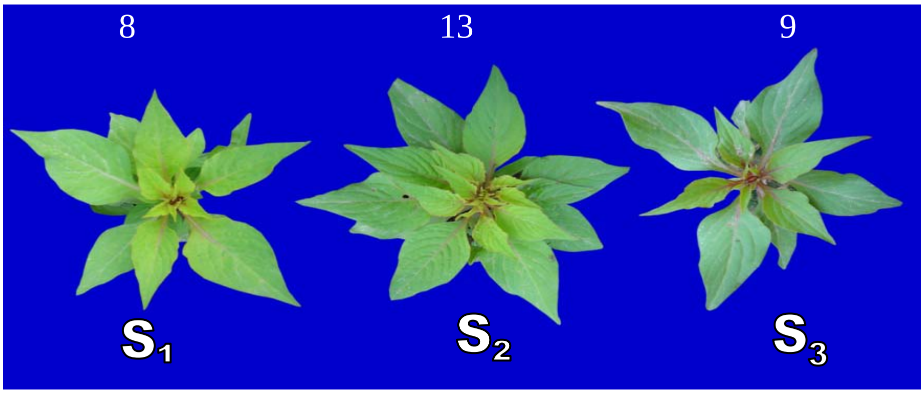

Plate-2: Effect of spacing on the leaf number of plant

Leaf number per plant of Cockscomb showed significant differences due to application of phosphorus (Appendix V). Fig. 7 represents a gradual increasing trend of leaf number with days after transplanting for different doses of phosphorus application. The highest leaf number (13) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the smallest number of leaf (9) was found in P_2 treatment (100 Kg P_2O_5/ha) at 40 DAT. Leaf number of plant was the lowest where there was the highest phosphorus applied to bed. Because with the increasing doze of phosphorus number of leaf increased starting from first treatment but after a certain level it decreased even it showed the lowest effect. Because excessive doze of phosphorus caused toxic condition and plant growth was hampered. There was no significant variation in term of leaf number between P_0 (control) (11) and P_2 (9) treated plant at 40 DAT. (Fig. 7)

Significant difference was observed due to the combined effect of spacing and phosphorus on leaf number at 20, 30 and 40 DAT (Appendix V). It was observed that highest leaf number (16) was produced by S_2P_1 and lowest leaf number (7) was obtained from S_3P_2 treatment at 40 DAT (Table 3). So the combination of the best spacing and the best phosphorus level showed the best performance in leaf number of cockscomb.

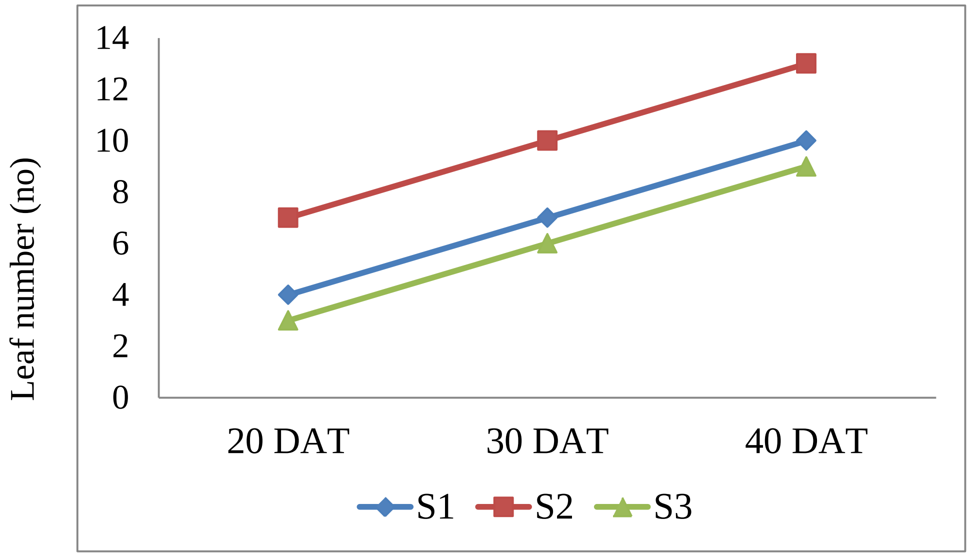

Fig. 6: Effect of spacing on the leaf number plant at different days after transplanting (DAT)

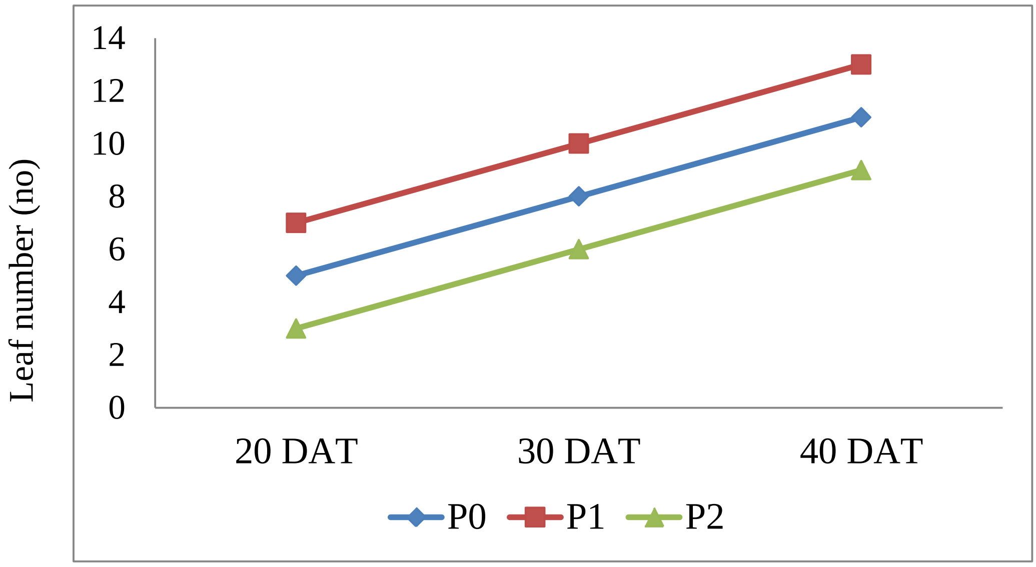

Fig. 7: Effect of Phosphorus on the leaf number of plant at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-3: Combined effect of spacing and phosphorus on the growth of Cockscomb at different days after transplanting (DAT)

No. of leaf/plant (No)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	4 cd	7 cd	10 cd
S_1P_1	6 bc	9 bc	12 bc
S_1P_2	3 cd	6 cd	9 cd
S_2P_0	7 ab	10 ab	13 ab
S_2P_1	10 a	13 a	16 a
S_2P_2	5 bc	8 bc	11 bc
S_3P_0	3 cd	6 cd	9 cd
S_3P_1	5 bc	8 bc	11 bc
S_3P_2	1 d	4 d	7 d
$LSD_{(0.05)}$	3.55	3.55	3.55
CV(%)	9.89	5.20	8.42

4.4 Diameter of crown

Significant difference in diameter of crown was found due to variation of plant spacing (Appendix VI). There was gradual increasing trend of crown diameter (Fig. 8) at 20, 30 and 40 DAT. The largest diameter of crown (19.2 cm) was obtained from medium spacing (S_2) and lowest diameter of crown (15.9 cm) was obtained from the highest spacing (S_1) at 40 DAT. There was no significant variation in term of diameter of crown between S_1 (20 cm) and S_3 (30 cm) treated plant at 40 DAT (Fig. 8)

Diameter of crown of Cockscomb showed significant differences due to application of phosphorus (Appendix VI). Fig. 9 represents a gradual increasing trend of crown diameter with days after transplanting for different doses of phosphorus application. The highest diameter (18.6 cm) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the smallest diameter of crown (15.9 cm) was found in P_0 treatment at 40 DAT. There was significant variation in term crown diameter between P_0 (control) (15.9 cm) and P_2 (17.3 cm) treated plant at 40 DAT. (Fig. 9)

Significant difference was observed due to the combined effect of spacing and phosphorus on crown diameter at 20, 30 and 40 DAT (Appendix VI). It was observed that highest diameter of crown (21.7 cm) was produced by S_2P_1 and lowest diameter of crown (17 cm) was obtained from S_3P_2 treatment at 40 DAT (Table 4).

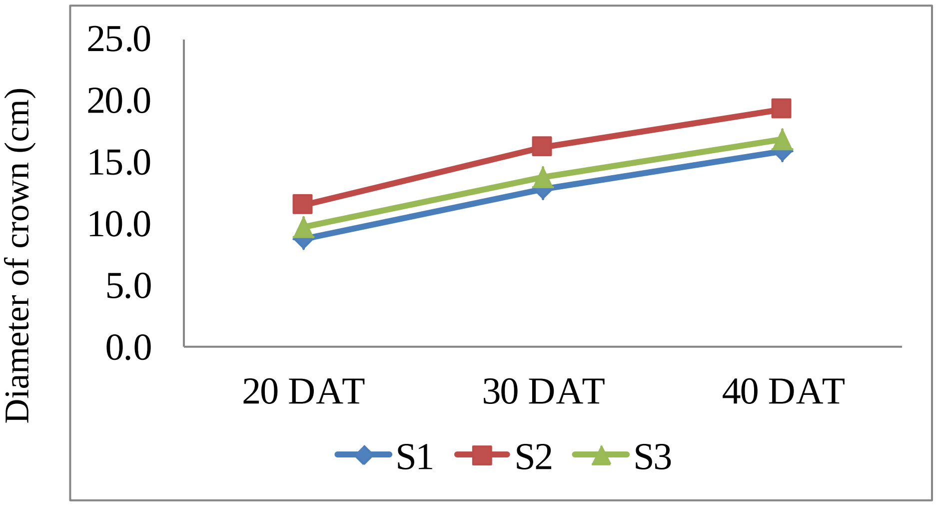

Fig. 8: Effect of spacing on diameter of crown of plant at different days after transplanting (DAT)

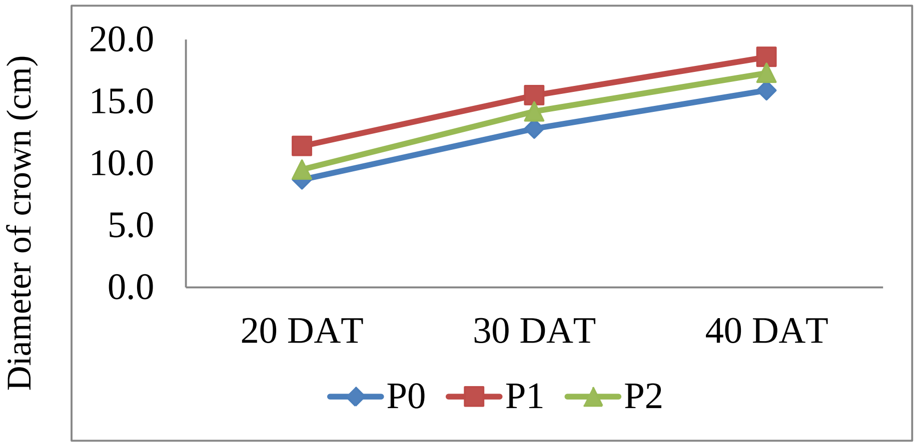

Fig. 9: Effect of Phosphorus on diameter of crown of plant at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-4: Combined effect of spacing and phosphorus on the growth of Cockscomb at different days after transplanting (DAT)

Diameter of crown (cm)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	7.00 c	11.10 d	14.20 d
S_1P_1	10.90 ab	15.00 abc	18.10 abc
S_1P_2	8.20 bc	12.30 cd	15.40 cd
S_2P_0	9.20 bc	13.30 bcd	16.40 bcd
S_2P_1	14.50 a	18.60 a	21.70 a
S_2P_2	10.70 b	16.60 ab	19.70 ab
S_3P_0	10.00 bc	14.10 bcd	17.20 bcd
S_3P_1	9.00 bc	13.10 bcd	16.20 bcd
S_3P_2	9.80 bc	13.90 bcd	17.00 bcd
$LSD_{(0.05)}$	3.60	3.77	3.77
CV(%)	2.96	5.31	2.57

4.5 Dry weight of plant

Significant difference in dry weight of plant was found due to variation of plant spacing (Appendix VII). There was gradual increasing trend of dry weight (Fig. 10) at 20, 30 and 40 DAT. The highest dry weight of plant (108.6 g) was obtained from medium spacing (S_2) and lowest dry weight of plant (103.5 g) was obtained from the lowest spacing (S_3) at 40 DAT. There was no significant variation in term of dry weight of plant between S_1 (20 cm) and S_3 (30 cm) treated plant at 40 DAT (Fig. 10)

Dry weight of plant of Cockscomb showed significant differences due to application of phosphorus (Appendix VII). Fig. 11 represents a gradual increasing trend of dry weight of plant with days after transplanting for different doses of phosphorus application. The highest dry weight of plant (108.2 g) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the lowest dry weight of plant (104.7 g) was found in P_2 treatment at 40 DAT. There was no significant variation in term of dry weight of plant between P_0 (control) (105.1 g) and P_2 (104.7 g) treated plant at 40 DAT. (Fig. 11)

Significant difference was observed due to the combined effect of spacing and phosphorus on dry weight of plant at 20, 30 and 40 DAT (Appendix VII). It was observed that highest dry weight of plant (112.8 g) was produced by S_2P_1 and lowest dry weight of plant (103.1 g) was obtained from S_3P_2 treatment at 40 DAT (Table 5).

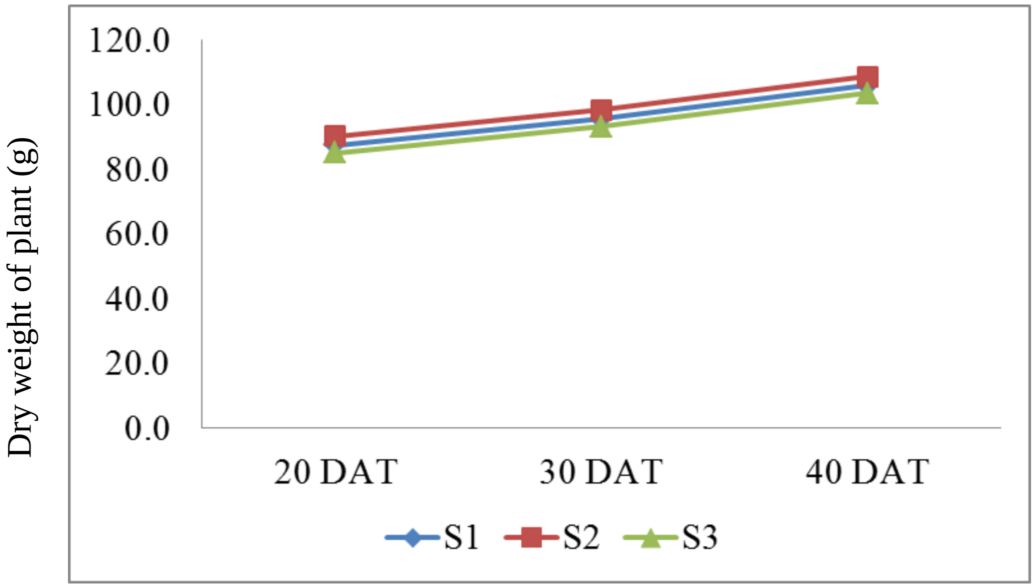

Fig. 10: Effect of spacing on the dry weight of plant at different days after transplanting (DAT)

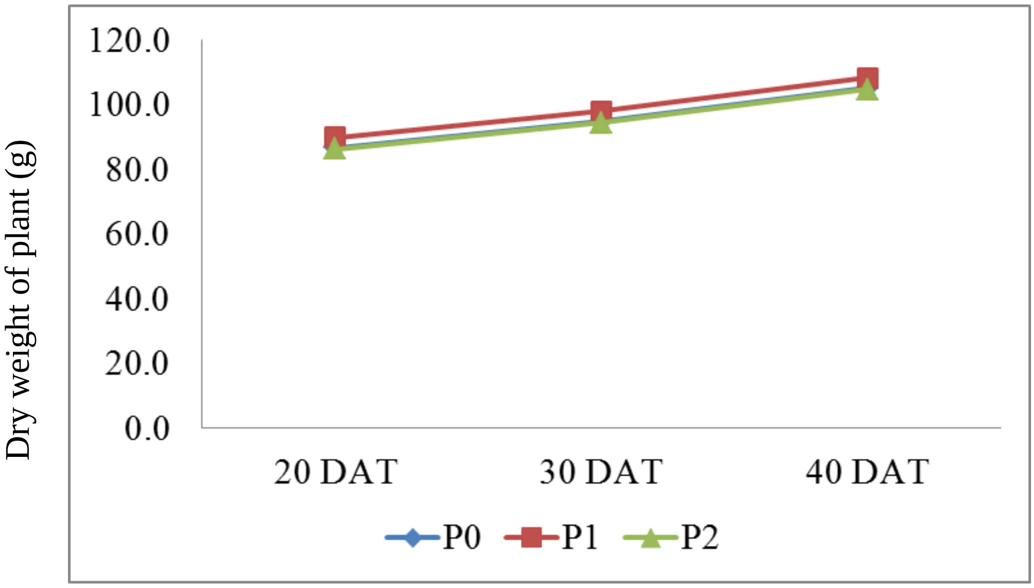

Fig. 11: Effect of Phosphorus on the dry weight of plant at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-5: Combined effect of spacing and phosphorus on the yield of Cockscomb at different days after transplanting (DAT)

Dry weight of plant (g)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	86.30 bc	94.50 bc	104.70 bc
S_1P_1	90.30 b	98.50 b	108.60 b
S_1P_2	85.80 c	94.00 c	104.20 c
S_2P_0	87.50 bc	95.70 bc	105.90 bc
S_2P_1	94.50 a	102.70 a	112.80 a
S_2P_2	88.50 bc	96.70 bc	106.90 bc
S_3P_0	86.10 c	94.30 c	104.50 c
S_3P_1	84.60 c	92.80 c	103.10 c
S_3P_2	84.60 c	92.80 c	103.10 c
$LSD_{(0.05)}$	4.07	4.07	4.06
CV(%)	2.69	2.46	2.22

4.6 Spike length

Significant difference in spike length was found due to variation of plant spacing (Appendix VIII). There was gradual increasing trend of spike length (Fig. 12) at 20, 30 and 40 DAT. The highest spike length (16.6 cm) was obtained from medium spacing (S_2) and lowest stem height (12.1 cm) was obtained from the lowest spacing (S_3) at 40 DAT. This was due to decreasing of plant spacing competition on nutrient, light and moisture mounted up and length of spike affected. But in optimum spacing spike length showed the best performance. However, there was no significant variation in term of stem height between S_1 (20 cm) and S_3 (30 cm) treated plant at 40 DAT (Fig. 12)

Spike length of Cockscomb showed significant differences due to application of phosphorus (Appendix VIII). Fig. 13 represents a gradual increasing trend of spike length with days after transplanting for different doses of phosphorus application. The tallest spike (16.2 cm) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the spike length (12.1 cm) was found in P_2 treatment (100 Kg P_2O_5/ha) at 40 DAT. Length of spike of plant was the lowest where there was the highest phosphorus applied to bed.

Because with the increasing doze of phosphorus length of spike increased starting from first treatment but after a certain level it decreased even it showed the lowest effect. Because excessive doze of phosphorus caused toxic condition and plant growth was hampered. So there was no significant variation in term of spike length between P_0 (control) (14.0 cm) and P_2 (12.1 cm) treated plant at 40 DAT. (Fig. 13)

Significant difference was observed due to the combined effect of spacing and phosphorus on spike length at 20, 30 and 40 DAT (Appendix VIII). It was observed that tallest (19.2 cm) spike was produced by S_2P_1 and shortest spike (10.2 cm) was obtained from S_3P_2 treatment at 40 DAT (Table 6). So the combination of the best spacing and the best phosphorus level showed the best performance in spike length of cockscomb.

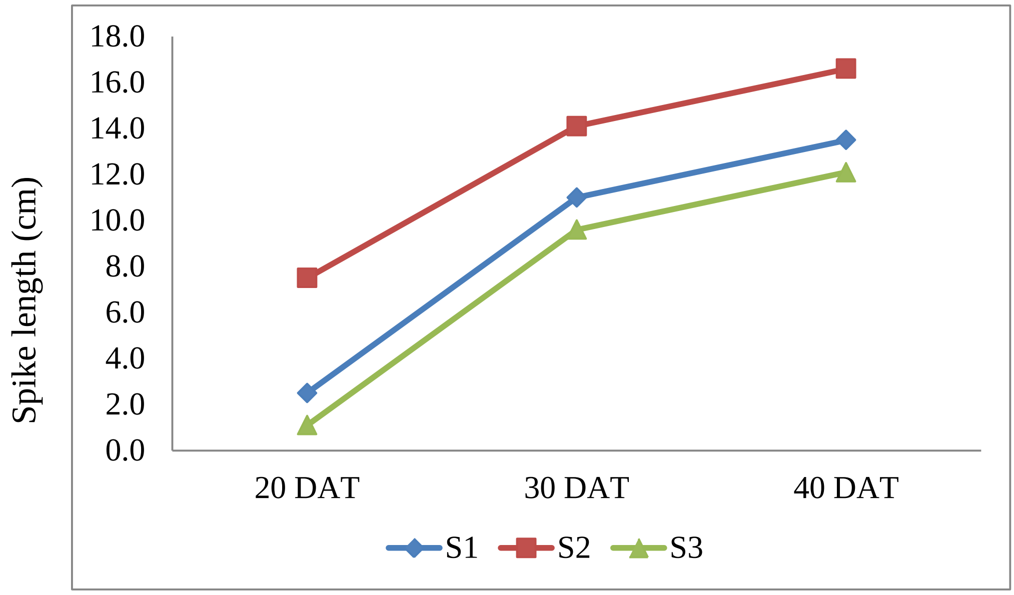

Fig. 12: Effect of spacing on the length of spike of plant at different days after transplanting (DAT)

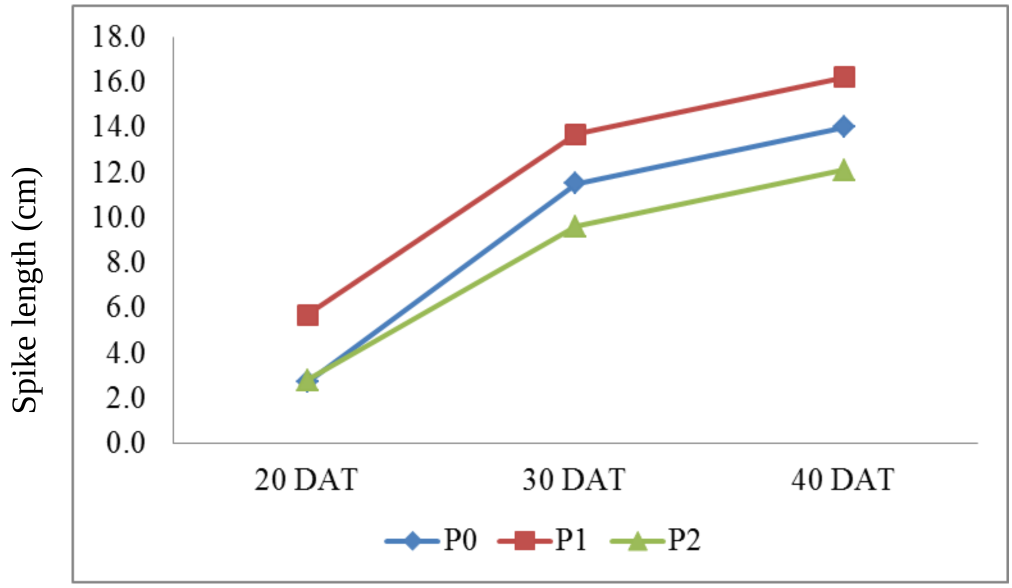

Fig. 13: Effect of Phosphorus on the length of spike of plant at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-6: Combined effect of spacing and phosphorus on the growth of Cockscomb at different days after transplanting (DAT)

Length of spike (cm)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	0.00 d	10.50 cd	13.00 cd
S_1P_1	2.80 cd	12.90 bc	15.40 bc
S_1P_2	4.80 bc	9.70 cd	12.20 cd
S_2P_0	8.00 ab	14.10 ab	16.60 ab
S_2P_1	10.70 a	16.70 a	19.20 a
S_2P_2	3.70 bcd	11.60 bc	14.10 bc
S_3P_0	0.00 d	9.90 cd	12.40 cd
S_3P_1	3.50 bcd	11.40 bc	13.90 bc
S_3P_2	0.00 d	7.70 d	10.20 d
$LSD_{(0.05)}$	4.68	3.47	3.47
CV(%)	2.08	7.24	4.19

4.7 Spike tip breadth

Significant difference in breadth of tip of spike was found due to variation of plant spacing (Appendix IX). There was gradual increasing trend of spike tip breadth (Fig. 14) at 20, 30 and 40 DAT. The highest spike tip breadth (4.7 cm) was obtained from medium spacing (S_2) and lowest breadth (2.8 cm) was obtained from the lowest spacing (S_3) at 40 DAT. This was due to decreasing of plant spacing inters plant competition on nutrient, light and moisture mounted up and spike tip breadth affected. But in optimum spacing spike tip breadth showed the best performance. There was no significant variation in term of stem height between S_1 (20 cm) and S_3 (30 cm) treated plant at 40 DAT (Fig. 14)

Spike tip breadth of Cockscomb showed significant differences due to application of phosphorus (Appendix IX). Fig. 15 represents a gradual increasing trend of spike tip breadth with days after transplanting for different doses of phosphorus application. The highest breadth spike (4.4 cm) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the smallest breadth of tip of spike (2.6 cm) was found in P_0 treatment at 40 DAT. Spike tip breadth was the lowest where there was no phosphorus applied to bed. With the increasing doze of phosphorus spike tip breadth of cockscomb increased but after a certain level it decreased.

Because excessive doze of phosphorus caused toxic condition and plant growth was hampered. So, there was significant variation in term of breadth of tip of spike between P_0 (control) (2.6 cm) and P_2 (3.6 cm) treated plant at 40 DAT. (Fig. 15)

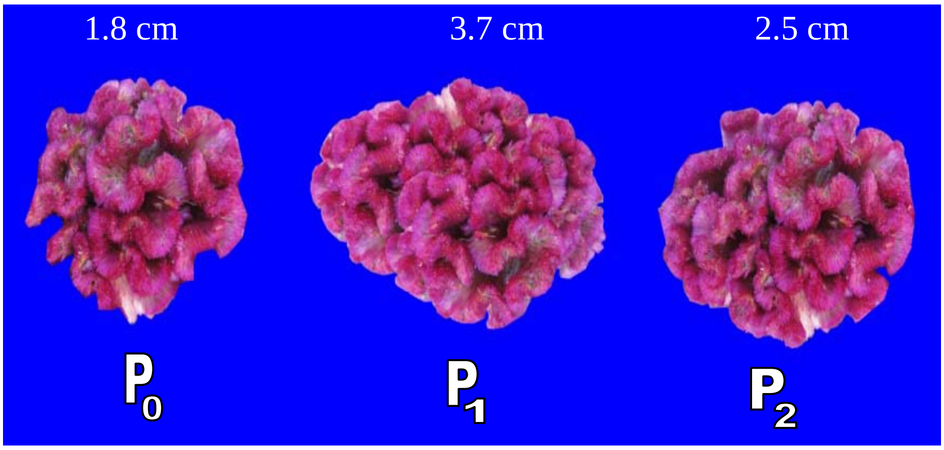

Plate-3: Effect of Phosphorus on the breadth of tip of spike

Significant difference was observed due to the combined effect of spacing and phosphorus on of breadth of tip of spike at 20, 30 and 40 DAT (Appendix IX). It was observed that highest breadth of tip of spike (6.6 cm) was produced by S_2P_1 and shortest tip of spike (2.5 cm) was obtained from S_3P_2 treatment at 40 DAT (Table 7). So the combination of the best spacing and the best phosphorus level showed the best performance in spike tip breadth of cockscomb.

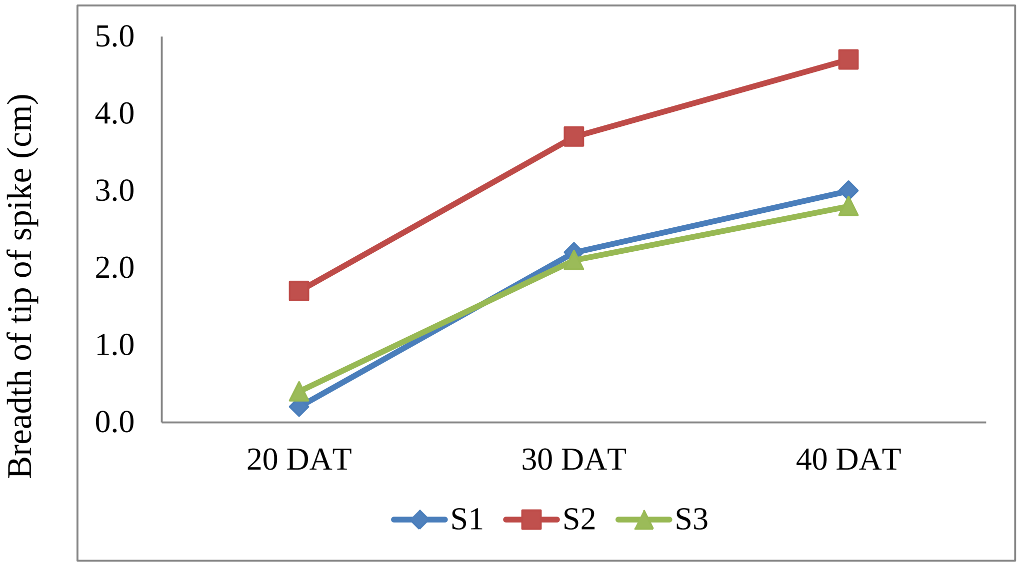

Fig. 14: Effect of spacing on the breadth of tip of spike of plant at different days after transplanting (DAT)

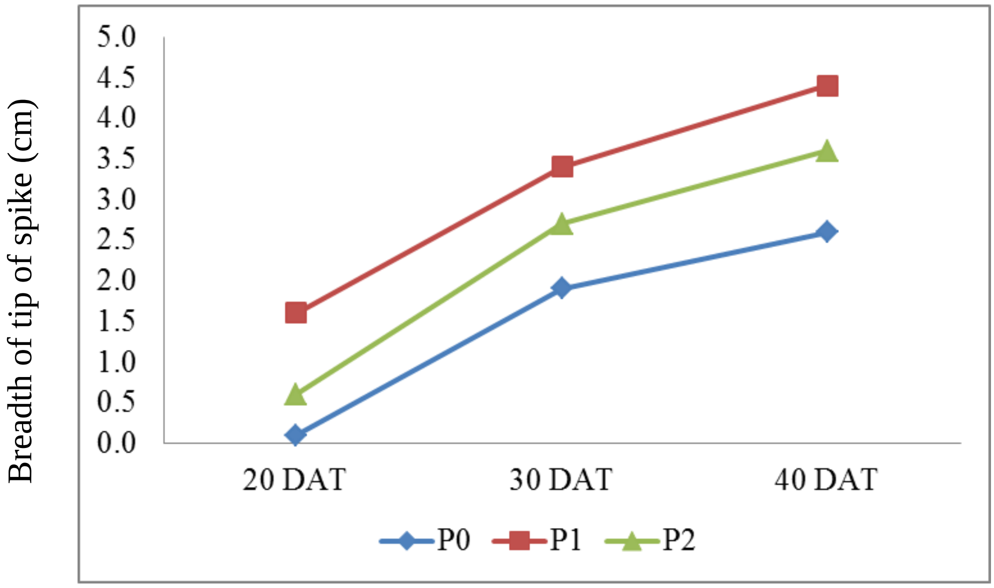

Fig. 15: Effect of Phosphorus on the breadth of tip of spike of plant at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-7: Combined effect of spacing and phosphorus on the growth of Cockscomb at different days after transplanting (DAT)

Breadth of tip of spike (cm)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	0.00 c	1.70 c	2.00 e
S_1P_1	0.10 c	2.20 bc	3.30 cd
S_1P_2	0.60 c	2.70 bc	3.80 bc
S_2P_0	0.40 c	2.20 bc	3.00 cde
S_2P_1	3.40 a	5.50 a	6.60 a
S_2P_2	1.20 b	3.30 b	4.40 b
S_3P_0	0.00 c	1.70 c	2.70 de
S_3P_1	1.40 b	2.50 bc	3.40 bcd
S_3P_2	0.00 c	2.10 c	2.50 de
$LSD_{(0.05)}$	0.66	1.24	1.09
CV(%)	7.33	6.81	7.69

4.8 Dry weight of spike

Significant difference in dry weight of spike was found due to variation of plant spacing (Appendix X). There was gradual increasing trend of dry weight of spike (Fig. 16) at 20, 30 and 40 DAT. The highest dry weight of spike (19.6 g) was obtained from medium spacing (S_2) and lowest dry weight of spike (15.4 g) was obtained from the lowest spacing (S_3) at 40 DAT. There was no significant variation in term of dry weight of spike between S_1 (20 cm) and S_3 (30 cm) treated plant at 40 DAT (Fig. 16)

Dry weight of spike of Cockscomb showed significant differences due to application of phosphorus (Appendix X). Fig. 17 represents a gradual increasing trend of dry weight of spike with days after transplanting for different doses of phosphorus application. The highest dry weight of spike (19.8 g) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the lowest dry weight of spike (15.7 g) was found in P_2 treatment at 40 DAT. There was no significant variation in term of dry weight of spike between P_0 (control) (16.2 g) and P_2 (57.7 g) treated plant at 40 DAT. (Fig. 17)

Significant difference was observed due to the combined effect of spacing and phosphorus on dry weight of spike at 20, 30 and 40 DAT (Appendix X). It was observed that highest dry weight of spike (22.9 g) was produced by S_2P_1 and lowest dry weight of spike (13.8 g) was obtained from S_3P_2 treatment at 40 DAT (Table 8).

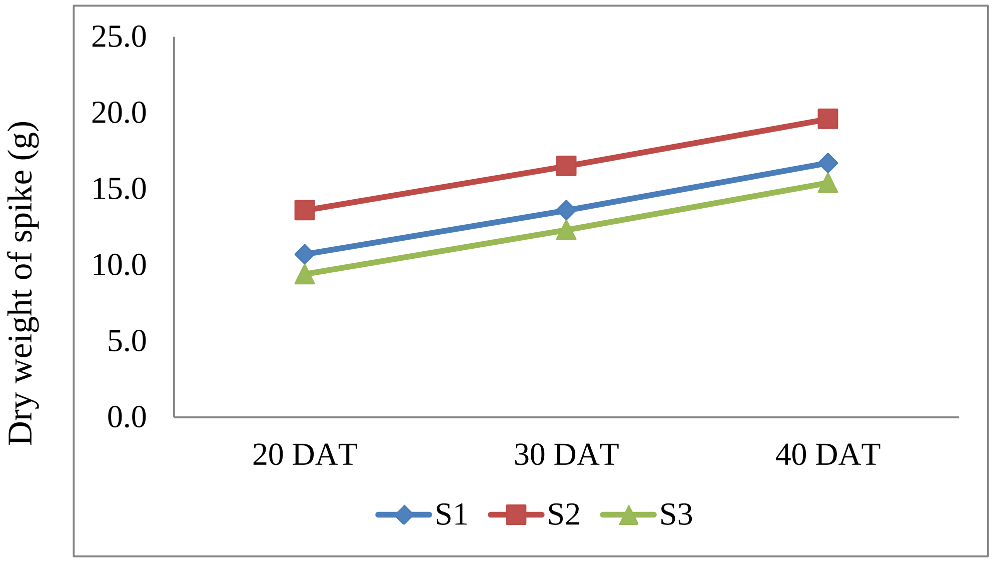

Fig. 16: Effect of spacing on the dry weight of spike of plant at different days after transplanting (DAT)

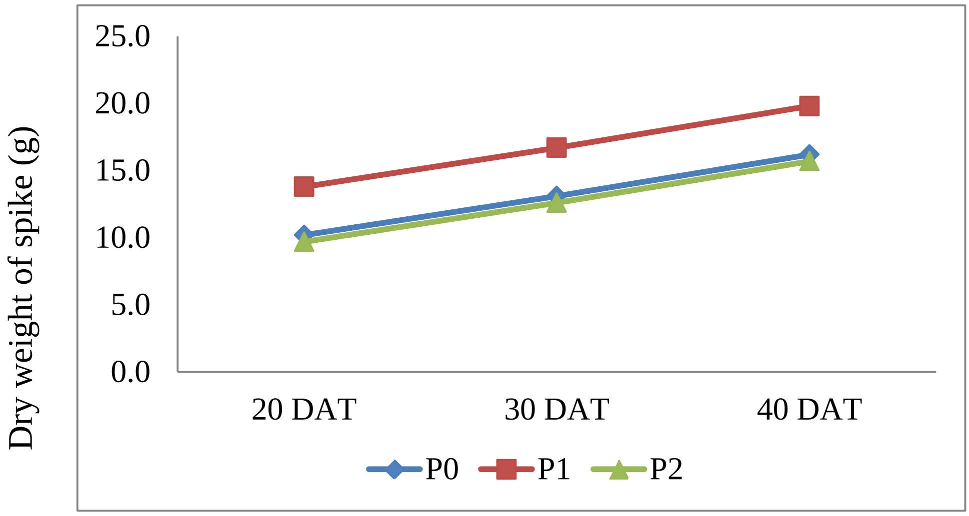

Fig. 17: Effect of Phosphorus on the dry weight of spike of plant at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-8: Combined effect of spacing and phosphorus on the yield of Cockscomb at different days after transplanting (DAT)

Dry weight of spike (g)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	9.00 cd	12.00 cd	15.10 cd
S_1P_1	13.30 b	16.20 b	19.30 b
S_1P_2	9.70 cd	12.60 cd	15.70 cd
S_2P_0	12.40 bc	15.30 bc	18.40 bc
S_2P_1	16.90 a	19.80 a	22.90 a
S_2P_2	11.60 bc	14.50 bc	17.60 bc
S_3P_0	9.20 cd	12.10 cd	15.20 cd
S_3P_1	11.30 bc	14.20 bc	17.30 bc
S_3P_2	7.80 d	10.70 d	13.80 d
$LSD_{(0.05)}$	3.40	3.40	3.40
CV(%)	7.44	3.86	1.37

4.9 First initiated flower

Significant difference in first initiated flower was found due to variation of plant spacing (Appendix XI). The data was taken (Fig. 18) at 20 DAT. The highest number of initiated flower (5 No) was obtained from medium spacing (S_2) and lowest number of initiated flower (1) was obtained from the highest spacing (S_1) at 20 DAT. There was no significant variation in term of number of first initiated flower between S_1 (20 cm) and S_3 (30 cm) treated plant at 20 DAT (Fig. 18)

Number of first initiated flower of Cockscomb showed significant differences due to application of phosphorus (Appendix XI). Fig. 19 represents a variation of number of first initiated flowers 20 days after transplanting (DAT) for different doses of phosphorus application. The highest number of initiated flower (6) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the lowest number of initiated flower (1) was found in P_0 treatment at 20 DAT. First initiated flowers were the lowest where there was no phosphorus applied to bed. With the increasing doze of phosphorus number of initiated flower increased but after a certain level it decreased. Because excessive doze of phosphorus caused toxic condition and plant growth was hampered. So there was no significant variation in term of number of first initiated flower between P_0 (control) (1) and P_2 (2) treated plant at 20 DAT. (Fig. 19)

Significant difference was observed due to the combined effect of spacing and phosphorus on the number of first initiated flowers at 20 DAT (Appendix XI). It was observed that highest number of initiated flower (9) was produced by S_2P_1 and the lowest number of first initiated flower (3) was obtained from S_3P_2 treatment at 20 DAT (Table 9).

4.10 Number of 80% emergence flower

Significant difference in 80% emergence flower was found due to variation of plant spacing (Appendix XII). The data was taken (Fig. 20) at 30 DAT. The highest number of 80% emergence flower (6) was obtained from medium spacing (S_2) and lowest number of 80% emergence flower (3) was obtained from the highest spacing (S_1) at 30 DAT. There was no significant variation in term of number of 80% emergence flower between S_1 (20 cm) and S_3 (30 cm) treated plant at 30 DAT (Fig. 20)

Number of 80% emergence flower of Cockscomb showed significant differences due to application of phosphorus (Appendix XII). Fig. 21 represents a variation of number of 80% emergence flowers 30 days after transplanting (DAT) for different doses of phosphorus application. The highest number of 80% emergence flower (5) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the lowest number of 80% emergence flower (3) was found in P_0 treatment at 30 DAT. However, there was no significant variation in term of number of first initiated flower between P_0 (control) (3) and P_2 (3) treated plant at 30 DAT. (Fig. 21)

Significant difference was observed due to the combined effect of spacing and phosphorus on the number of 80% emergence flowers at 30 DAT (Appendix XII). It was observed that highest number of 80% emergence flower (8) was produced by S_2P_1 and the lowest number of 80% emergence flower (2) was obtained from S_3P_2 treatment at 30 DAT (Table 9).

4.11 Duration of senescence for 80% flower

Significant difference in duration of 80% senescence flower was found due to variation of plant spacing (Appendix XII). The data was taken (Fig. 22) at last day of the experiment. The maximum duration of 80% senescence flower (38 days) was obtained from medium spacing (S_2) and minimum duration of 80% senescence flower (33 days) was obtained from the lowest spacing (S_1). This was due to decreasing of plant spacing competition on nutrient, light and moisture mounted up and duration of flower senescence affected. But in optimum spacing duration of flower senescence showed the highest. However, here was no significant variation in term of duration of 80% senescence flower between S_1 (20 cm) and S_3 (20 cm) treated plant. (Fig. 22)

Duration of 80% senescence flower of Cockscomb showed significant differences due to application of phosphorus (Appendix XII). Fig. 23 represents a variation of duration of 80% senescence flowers for different doses of phosphorus application. The maximum duration of 80% senescence flower (38 days) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the lowest duration of 80% senescence flower (34 days) was found in P_0 treatment. Duration of 80% flower senescence was the lowest where there was no phosphorus applied to bed. Gradually duration of senescence increased because with the increasing doze of phosphorus starting from first treatment to a certain level. Because excessive doze of phosphorus caused toxic condition and plant growth was hampered. There was no significant variation in term of duration of 80% senescence flower between P_0 (control) (34 days) and P_2 (34 days) treated plant. (Fig. 23)

Significant difference was observed due to the combined effect of spacing and phosphorus on the duration of 80% senescence flowers (Appendix XII). It was observed that highest duration of 80% senescence flower (35 days) was produced by S_2P_1 and the lowest duration of 80% senescence flower (32) was obtained from S_3P_2 treatment (Table 9). So the combination of the best spacing and the best phosphorus level showed the best performance in spike tip breadth of cockscomb.

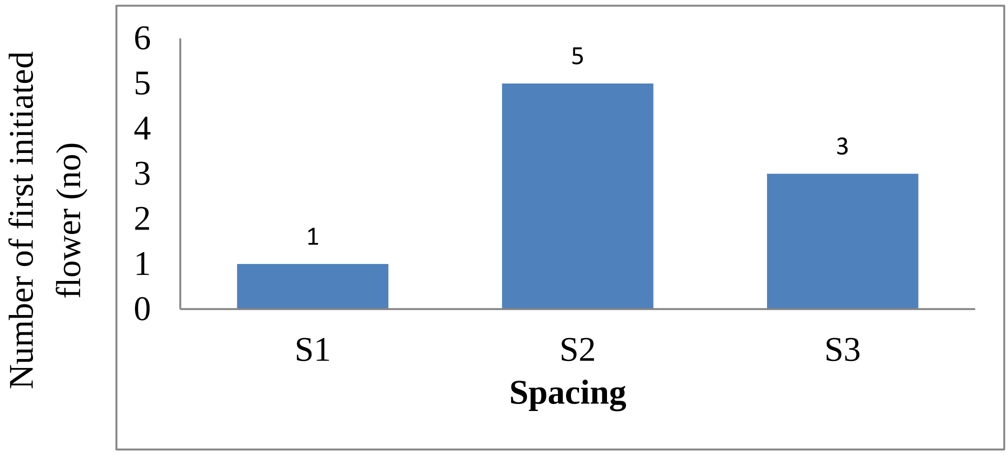

Fig. 18: Effect of spacing on the number of first initiated flower at 20 days after transplanting (DAT)

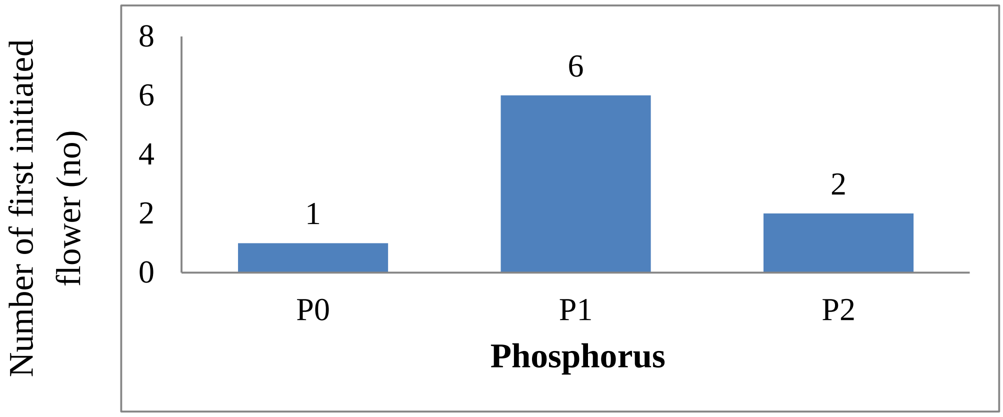

Fig. 19: Effect of phosphorus on number of first initiated flower at 20 days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

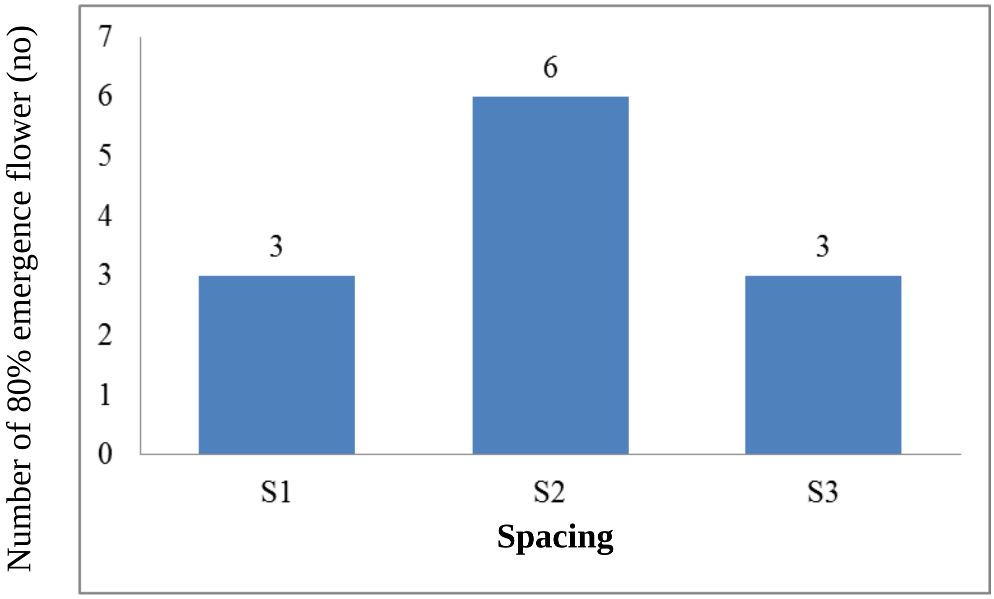

Fig. 20: Effect of spacing on the number of 80% emergence flower at 30 days after transplanting (DAT)

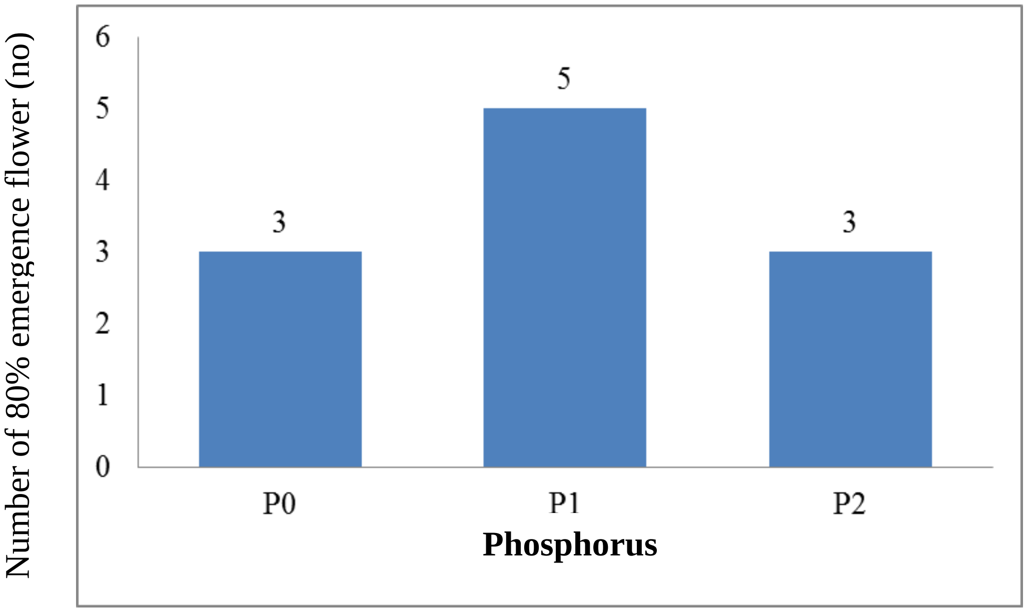

Fig. 21: Effect of Phosphorus on the number of 80% emergence flower at 30 days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

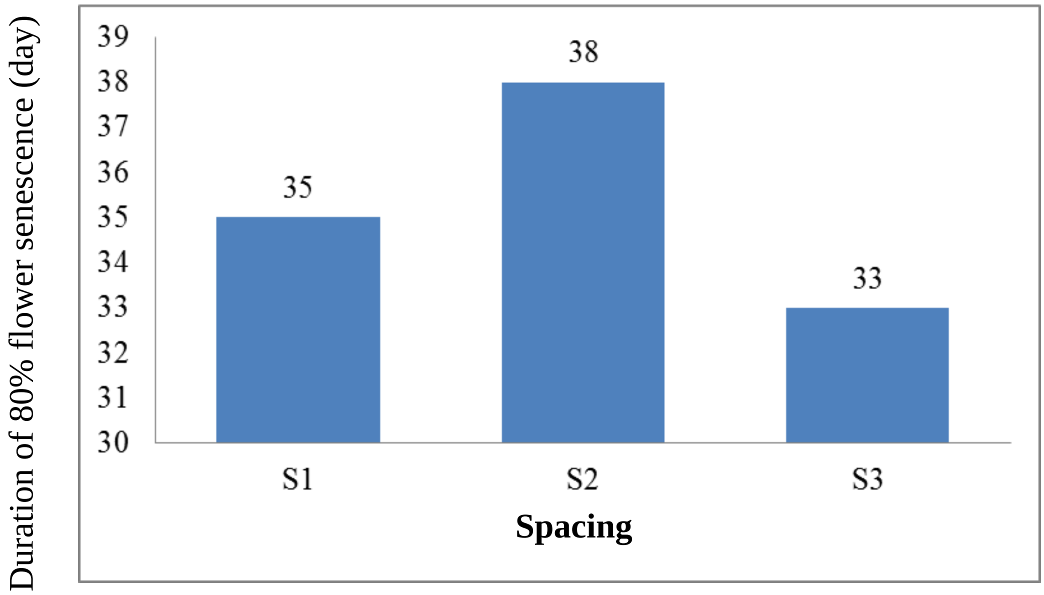

Fig. 22: Effect of spacing on the duration of 80% flower senescence.

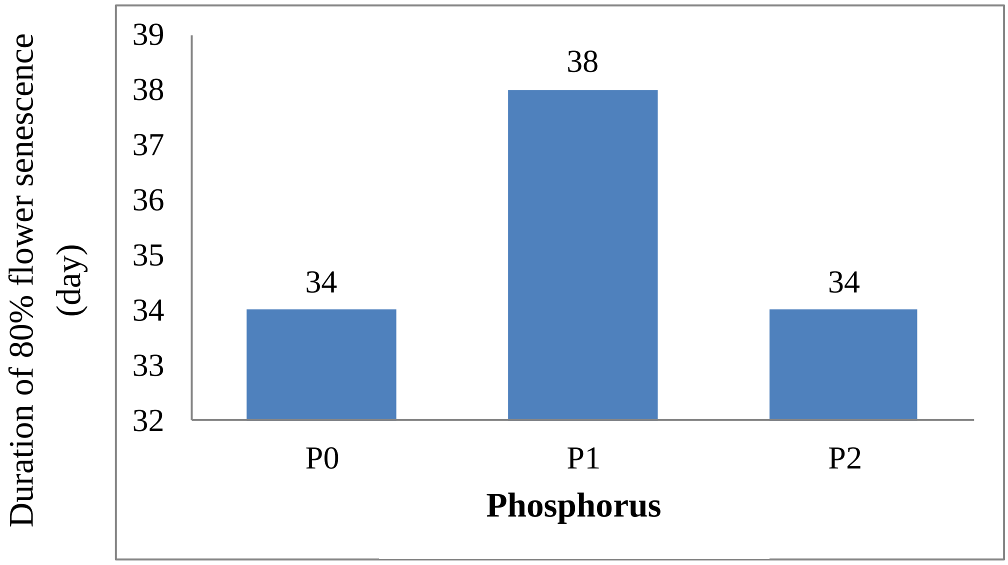

Fig. 23: Effect of Phosphorus on the duration of 80% flower senescence

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-9: Combined effect of spacing and phosphorus on the flowering of Cockscomb at different days after transplanting (DAT)

Treatment	Number of first initiated flower (No)	Number of 80% emergence flower (No)	Duration of senescence for 80% flower (Day)
S_1P_0	0 d	2 c	34 bc
S_1P_1	3 bcd	3 bc	38 ab
S_1P_2	1 cd	3 bc	34 d
S_2P_0	4 bc	6 ab	35 bc
S_2P_1	9 a	8 a	42 a
S_2P_2	4 bcd	6 ab	36 bc
S_3P_0	0 d	2 c	34 bc
S_3P_1	6 ab	5 abc	33 c
S_3P_2	3 bcd	2 c	32 c
$LSD_{(0.05)}$	4.23	3.35	4.07
CV(%)	9.51	5.44	6.58

4.12 Number of spike

Significant difference in spike number was found due to variation of plant spacing (Appendix XIII). There was gradual increasing trend of spike number (Fig. 24) at 20, 30 and 40 DAT. The highest spike number (126,582/ha) was obtained from medium spacing (S_2) and lowest spike number (25,316/ha) was obtained from the lowest spacing (S_3) at 40 DAT. This was due to decreasing of plant spacing competition on nutrient, light and moisture mounted up and number flower effected.But in optimal spacing number of flower showed the highest result. However, here was no significant variation in term of leaf number between S_1 (20 cm) and S_3 (30 cm) treated plant at 40 DAT. (Fig. 24)

Spike number per plant of Cockscomb showed significant differences due to application of phosphorus (Appendix XIII). Fig. 25 represents a gradual increasing trend of spike number with days after transplanting for different doses of phosphorus application. The highest spike number (101,265/ha) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the smallest number of spike (20,320/ha) was found in P_0 treatment at 40 DAT. Number flower was the lowest where there was no phosphorus applied to bed. Gradually flower number of cockscomb increased with the increasing doze of phosphorus starting from first treatment to a certain level. After a certain limit it declined because excessive doze of phosphorus caused toxic condition and plant growth was hampered. However, there was no significant variation in term of spike number between P_0 (control) (2) and P_2 (3) treated plant at 40 DAT. (Fig. 25)

Significant difference was observed due to the combined effect of spacing and phosphorus on spike number at 20, 30 and 40 DAT (Appendix XIII). It was observed that highest spike number (132,531/ha) was produced by S_2P_1 and lowest spike number (27,260/ha) was obtained from S_3P_o treatment at 40 DAT (Table 10). So the combination of the best spacing and the best phosphorus level showed the best performance in spike production of cockscomb.

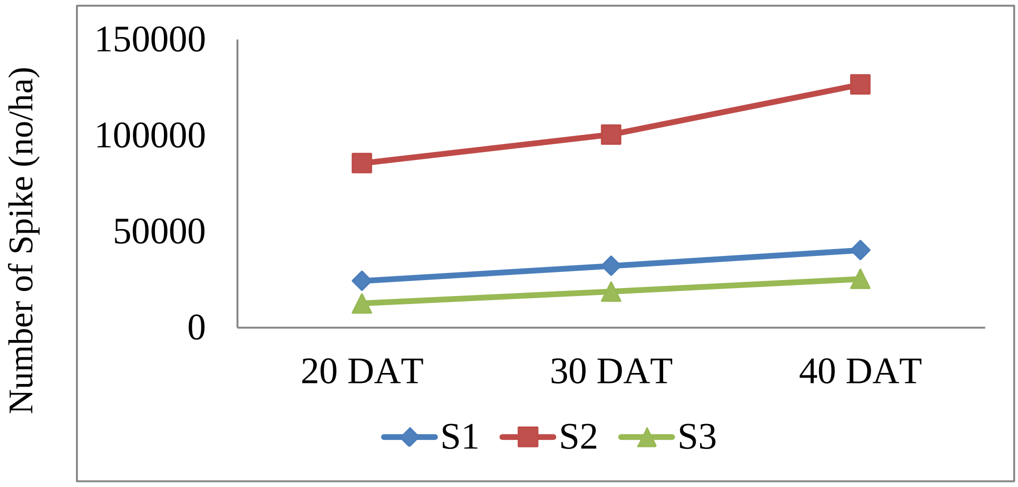

Fig. 24: Effect of spacing on the flowering at different days after transplanting (DAT)

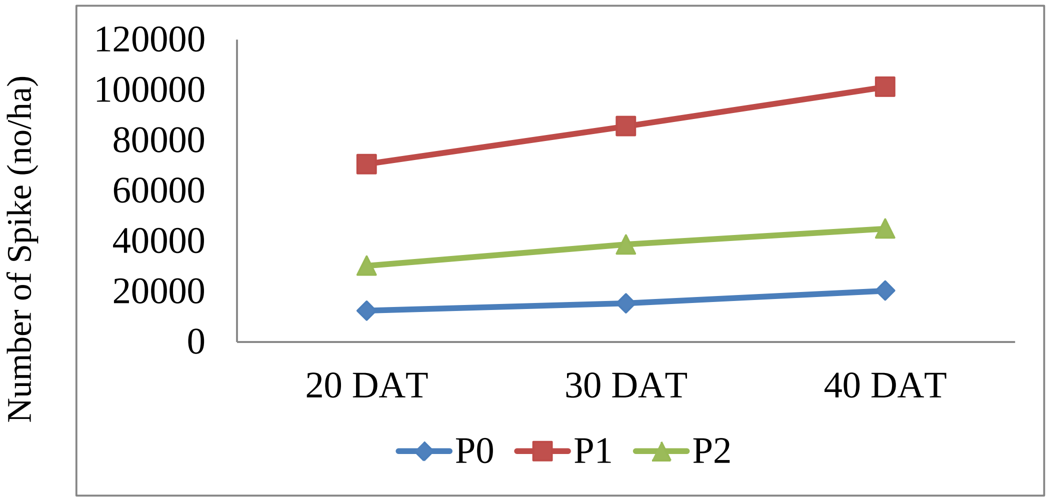

Fig. 25: Effect of Phosphorus on the flowering at different days after transplanting (DAT)

S_1=35×30 cm, S_2= 35×25 cm, S_3= 35×20 cm and P_0= 0 Kg P_2O_5/ha, P_1= 50 Kg P_2O_5/ha, P_2= 100 Kg P_2O_5/ha.

Table-10: Combined effect of spacing and phosphorus on the flowering of Cockscomb at different days after transplanting (DAT)

Number of spike (no/ha)

Treatment	20 DAT	30 DAT	40 DAT
S_1P_0	10,260 d	20,260 d	27,260 d
S_1P_1	70,250 bcd	75,250 bcd	80,250 bcd
S_1P_2	70,930 bc	80,230 bc	85,230 bc
S_2P_0	60,250 bcd	70,250 bcd	80,250 bcd
S_2P_1	110,531a	120,531a	132,531a
S_2P_2	72,230 b	82,230 b	95,230 b
S_3P_0	10,260 d	20,260 d	27,260 d
S_3P_1	10,580 cd	11,580 cd	26,580 cd
S_3P_2	10,580 cd	11,580 cd	26,580 cd
$LSD_{(0.05)}$	1.01	1.15	1.15
CV(%)	0.98	4.00	7.65

4.13 Economic analysis

Input costs on lands perpetration, Seed costs, fertilizer, irrigation and man power were required for per unit plot all the converted from sowing to harvest of Cockscomb recorded for unit plot and converted into cost per hectare. Prices of Cockscomb were considered as per market rate. The economic analysis was done to find out the gross and net return and the benefit cost ratio in the present study were calculated and presented under the following headings.

4.14 Gross return

Combination of plant spacing and phosphorus showed different gross return under the trial (Table 11). The highest gross return (TK. 243,037/ha) was observed from S_2P_1 combination and the lowest gross return (TK. 82,150/ha) was record from the treatment combination of $S_3P_{0.}$

4.15 Net return

In case of net return, different treatment combination showed remarkable variation. The highest net return (TK. 164,372/ha) was observed from S_2P_1 and the lowest net return (TK. 2,085/ha) was found from the treatment combination of S_3P_0 (Table 11).

4.16 Benefit cost ratio

The combination of plant spacing and sowing time for benefit cost ratio was different for treatment combination (Table 11). The highest benefit cost ratio (3.09:1) was recorded from S_2P_1 and the lowest benefit cost ratio (1.03:1) was record from S_3P_0. From economic point of view, it is apparent from the above results that the treatment combination of S_2P_1 was most profitable in comparison with the other combinations.

Table11. Cost and return of cock's comb cultivation as influenced by plant spacing and phosphorus.

Treatment(s) combination	Cost of production (Tk./ha)	Yield of harvest (no/ha)	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
S_1P_0	80065	27,260	82150	2085	1.03
S_1P_1	71615	80,250	195375	123760	2.73
S_1P_2	79465	85,230	195299	115834	2.46
S_2P_0	75915	80,250	195375	119460	2.57
S_2P_1	78665	132,531	243037	164372	3.09
S_2P_2	84515	95,230	191076	106561	2.26
S_3P_0	79965	27,260	82890	2925	1.03
S_3P_1	77665	26,580	151896	74231	1.96
S_3P_2	83515	26,580	151896	68381	1.82

• *Average price of single flower was 1.5 BDT*

SUMMARY AND CONCLUSION

The experiment was conducted at the experimental field, Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from March 2012 to May 2012. The objective of the study was to determine the influence of spacing and phosphorus on the growth and yield of amigo-mix celosia (dwarf variety). The experiment consisted of three levels of spacing, viz. S_1: 35 × 30 cm, S_2: 35 × 25 cm, S_2: 35 × 20 cm and three levels of phosphorus viz. P_0: 0 Kg p_2O_5/ha, P_1: 50 Kg P_2O_5/ha, P_2: 100 Kg P_2O_5/ha. The two factor experiment was laid out in a Randomized Completely Block Design (RCBD) with three replications. Size of each plot was 1.5m × 1.05m.

A significant variation was observed on different parameters under study due to different levels of spacing. The highest plant height (24.2 cm) was obtained from S_2 spacing and lowest plant height (19.7 cm) was obtained from the S_3 spacing at 40 DAT. The tallest plant (23.8 cm) was recorded from P_1 treated plant and the smallest plant (19.7 cm) was found in P_2 treatment at 40 DAT. In combined effect of spacing and phosphorus on plant the tallest (26.9 cm) plant was produced by S_2P_1 and shortest plant (17.8 cm) was obtained from S_3P_2 treatment at 40 DAT.

Regarding the stem height the highest stem height (16.6 cm) was obtained from S_2 spacing and lowest stem height (12.1 cm) was obtained from the S_3 spacing at 40 DAT. The tallest stem (16.2 cm) was recorded from P_1 treated plant and the smallest stem (12.1 cm) was found in P_2 treatment at 40 DAT. It was observed that tallest (19.2 cm) stem was produced by S_2P_1 and shortest plant (10.2 cm) was obtained from S_3P_2 treatment at 40 DAT.

The highest leaf number (13) was obtained from spacing S_2 and lowest leaf number (9) was obtained from the spacing S_3 at 40 DAT. The highest leaf number (13) was recorded from P_1 treated plant and the smallest number of leaf (9) was found in P_2 treatment at 40 DAT. It was observed that highest leaf number (16) was produced by S_2P_1 and lowest leaf number (7) was obtained from S_3P_2 treatment at 40 DAT.

The largest diameter of crown (19.2 cm) was obtained from medium spacing S_2 and lowest diameter of crown (15.9 cm) was obtained from the highest spacing S_1 at 40 DAT. The highest diameter (18.6 cm) was recorded from P_1 treated plant and the smallest diameter of crown (15.9 cm) was found in P_0 treatment at 40 DAT. It was observed that highest diameter of crown (21.7 cm) was produced by S_2P_1 and lowest diameter of crown (17 cm) was obtained from S_3P_2 treatment at 40 DAT.

The highest dry weight of plant (108.6 g) was obtained from spacing S_2 and dry weight of plant (103.5 g) was obtained from the lowest spacing S_3 at 40 DAT. The highest dry weight of plant (108.2 g) was recorded from P_1 treated plant and the lowest dry weight of plant (104.7 g) was found in P_2 treatment at 40 DAT. It was observed that highest dry weight of plant (112.8 g) was produced by S_2P_1 and lowest dry weight of plant (103.1 g) was obtained from S_3P_2 treatment at 40 DAT.

The highest spike length (16.6 cm) was obtained from spacing S_2 and lowest stem height (12.1 cm) was obtained from the lowest spacing S_3 at 40 DAT. The tallest spike (16.2 cm) was recorded from P_1 treated plant and the smallest stem (12.1 cm) was found in P_2 treatment at 40 DAT. It was observed that tallest (19.2 cm) spike was produced by S_2P_1 and shortest spike (10.2 cm) was obtained from S_3P_2 treatment at 40 DAT.

The highest spike tip breadth (4.7 cm) was obtained from medium spacing S_2 and lowest breadth (2.8 cm) was obtained from the lowest spacing S_3 at 40 DAT. The highest breadth spike (4.4 cm) was recorded from P_1 treated plant and the smallest breadth of tip of spike (2.6 cm) was found in P_0 treatment at 40 DAT.

It was observed that highest breadth of tip of spike (6.6 cm) was produced by S_2P_1 and shortest tip of spike (2.5 cm) was obtained from S_3P_2 treatment at 40 DAT.

The highest dry weight of spike (19.6 g) was obtained from spacing S_2 and lowest dry weight of spike (15.4 g) was obtained from the spacing S_3 at 40 DAT. The highest dry weight of spike (19.8 g) was recorded from treated plant and the lowest dry weight of spike (15.7 g) was found in P_2 treatment at 40 DAT. It was observed that highest dry weight of spike (22.9 g) was produced by S_2P_1 and lowest dry weight of spike (13.8 g) was obtained from S_3P_2 treatment at 40 DAT.

The highest number of first initiated flower (5) was obtained from medium spacing S_2 and lowest number of first initiated flower (1) was obtained from the highest spacing S_1 at 20 DAT. The highest number of first initiated flower (6) was recorded from P_1 treated plant and the lowest number of first initiated flower (1) was found in P_0 treatment at 20 DAT. It was observed that highest number of initiated flower (9) was produced by S_2P_1 and the lowest number of first initiated flower (3) was obtained from S_3P_2 treatment at 20 DAT.

The highest number of 80% emergence flower (6) was obtained from medium spacing S_2 and lowest number of 80% emergence flower (3) was obtained from the highest spacing S_1 at 30 DAT. The highest number of 80% emergence flower (5) was recorded from P_1 treated plant and the lowest number of 80% emergence flower (3) was found in P_0 treatment at 30 DAT. It was observed that highest number of 80% emergence flower (8) was produced by S_2P_1 and the lowest number of 80% emergence flower (2) was obtained from S_3P_2 treatment at 30 DAT.

The maximum duration of 80% senescence flower (38 days) was obtained from medium spacing S_2 and minimum duration of 80% senescence flower (33 days) was obtained from the lowest spacing S_1. The maximum duration of 80% senescence flower (38 days) was recorded from P_1 treated plant and the lowest duration of 80% senescence flower (34 days) was found in P_0 treatment.

It was observed that highest duration of 80% senescence flower (35 days) was produced by S_2P_1 and the lowest duration of 80% senescence flower (32) was obtained from S_3P_2 treatment.

There was gradual increasing trend of spike number at 20, 30 and 40 DAT. The highest spike number (126,582/ha) was obtained from medium spacing (S_2) and lowest spike number (25,316/ha) was obtained from the lowest spacing (S_3) at 40 DAT.

The highest spike number (101,265 no/ha) was recorded from P_1 (50 Kg P_2O_5/ha) treated plant and the smallest number of spike number (20,320/ha) was found in P_0 treatment at 40 DAT.

It was observed that highest spike number (132,531/ha) was produced by S_2P_1 and lowest spike number (27,260/ha) was obtained from S_3P_o treatment at 40 DAT (Table 10).

Conclusion

i) In case of spacing the results also showed that spacing up to a certain level had significant influence on growth and flowering of cockscomb. The growth and flowering of cockscomb in most of the cases increased with the decreasing level of spacing.

ii) In case of phosphorus the result also noticed that phosphorus up to certain level had significant influence on growth and flowering of cockscomb. The growth and flowering of cockscomb increased with the increasing level of phosphorus.

iii) From the combined effect, the combination of 35 cm × 25 cm and 50 Kg P_2O_5/ha gave the best result. So this combination is suitable for higher production of cockscomb.

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APPENDICES

Appendix I: Characteristics of the Horticulture Farm soil was analyzed by Soil Resources Development institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological feature	Characteristics
Location	Horticulture Garden, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil type	Shallow red brown terrace soil
Land type	Medium high land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% Clay	20
Textural class	Silty clay
P^H	5.8
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable k (me/100 g)	0.10
Available S (ppm)	45
% Silt	43

Source: SRDI, 2012

Appendix II: Monthly average air temperature, relative humidity and rainfall of the experimental site during the period from March 2012 to May 2012

Month	Air temperature (^oC)		Average relative humidity (%)	Average rainfall (mm)
	Maximum	Minimum		
March, 2012	31.4	19.6	54	11
April,2012	32.9	20.5	62	14
May,2012	20.2	21.5	65	25

Source: Bangladesh Meteorological Department (Climate and weather division) Agargaon, Dhaka-1207.

Appendix III: Analysis of variance of the data on the plant height of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Plant height (cm)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	47.60**	46.55**	46.35**
Factor B (Phosphorus)	2	38.31**	38.08**	37.00**
Interaction (A×B)	4	1.38*	1.39*	1.84*
Error	16	0.94	0.85	0.76

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix IV: Analysis of variance of the data on the stem height of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Stem height (cm)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	47.78**	47.22**	47.22**
Factor B (Phosphorus)	2	36.93**	36.50**	36.50**
Interaction (A×B)	4	1.25*	1.18NS	1.18*
Error	16	0.07	1.04	0.02

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix V: Analysis of variance of the data on the leaf number of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Leaf number (no)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	46.81**	46.85**	45.81**
Factor B (Phosphorus)	2	36.13**	36.25**	35.14**
Interaction (A×B)	4	02.32*	02.37*	02.31*
Error	16	0.21	0.41	0.29

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix VI: Analysis of variance of the data on the diameter of crown of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Diameter of crown (cm)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	17.89*	27.48**	27.48**
Factor B (Phosphorus)	2	17.73*	16.81**	16.81*
Interaction (A×B)	4	1.47**	1.47*	1.47*
Error	16	0.33	0.75	0.78

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix VII: Analysis of variance of the data on the dry weight of plant of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Dry weight of plant (g)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	57.60**	57.60**	56.61**
Factor B (Phosphorus)	2	33.26**	33.26**	32.35*
Interaction (A×B)	4	10.56*	10.56*	11.27*
Error	16	0.54	0.54	0.51

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix VIII: Analysis of variance of the data on the length of spike of plant of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Length of spike (cm)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	46.86**	47.22**	47.22**
Factor B (Phosphorus)	2	25.67**	36.50**	36.50*
Interaction (A×B)	4	2.04*	1.18**	1.18**
Error	16	0.31	0.25	0.20

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix IX: Analysis of variance of the data on the breadth of tip of spike of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Tip breadth (cm)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	5.56**	6.93**	9.15**
Factor B (Phosphorus)	2	5.45**	5.22**	7.84**
Interaction (A×B)	4	1.99*	2.21*	2.48**
Error	16	0.14	0.52	0.39

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix X: Analysis of variance of the data on the dry weight of spike of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Dry weight of spike (g)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	41.35**	41.29**	41.29**
Factor B (Phosphorus)	2	45.08**	44.97**	44.97**
Interaction (A×B)	4	1.06*	1.03*	1.03**
Error	16	0.86	0.85	0.85

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix XI: Analysis of variance of the data on the number of first initiated flower, 80% emergence flower and day to 80% flower senescence of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square		
		Number of first initiated flower	80% emergence flower	Days to 80% flower senescence
Factor A (Spacing)	2	45.03**	15.14**	15.14**
Factor B (Phosphorus)	2	49.37**	13.48**	13.48*
Interaction (A×B)	4	1.81*	1.48*	1.48*
Error	16	0.98	0.74	0.74

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix XII: Analysis of variance of the data on the number of spike of cockscomb at different days after transplanting (DAT)

Source of variation	Degrees of freedom	Mean square Number of spike (no)		
		20 DAT	30 DAT	40 DAT
Factor A (Spacing)	2	5.59**	8.33**	9.33**
Factor B (Phosphorus)	2	6.37**	9.00**	9.00*
Interaction (A×B)	4	1.87**	2.66**	2.66**
Error	16	0.34	0.44	0.44

****:** Significant at 0.01 level of probability ***:** Significant at 0.05 level of probability

NS**:** Not significant

Appendix XIII: Production cost of cockscomb per hectare as influenced by spacing and phosphorus

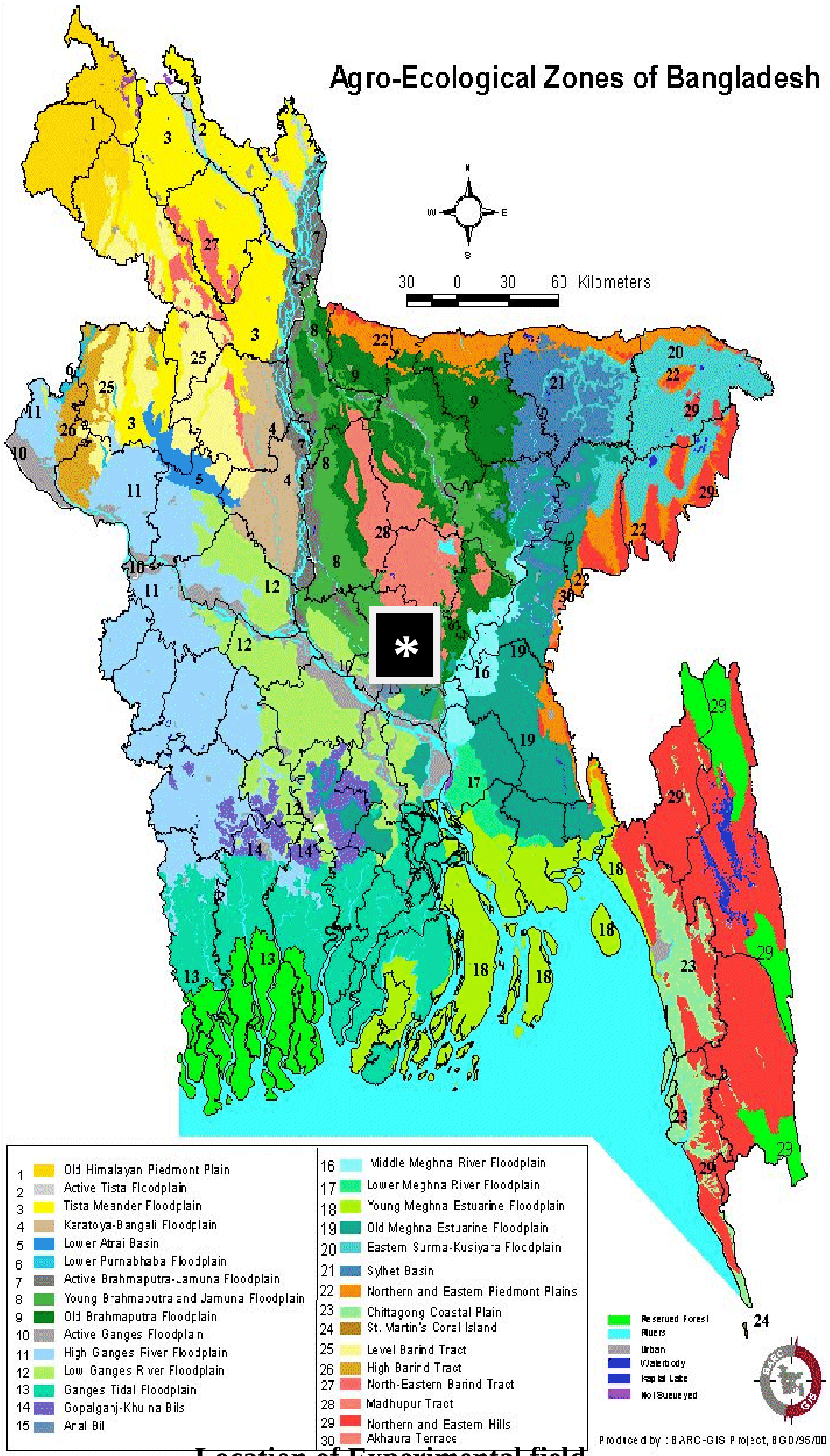
A. Input cost

Treatments Combination	Labour Cost (Tk)	Plugging Cost (Tk)	Seed Cost (Tk)	Irrigation Cost (Tk)	Pesticides Cost (Tk)	Weeding Cost (Tk)	Fertilizers Cost (Tk)		Total Cost (Tk)
							Cowdung	TSP	
S_1P_0	11000	3000	1500	2500	2000	2000	5000	0	27000
S_1P_1	1000	3000	1450	2500	2000	2000	5000	1600	18550
S_1P_2	8000	3000	1400	2500	2000	2000	5000	2500	26400
S_2P_0	7000	3000	1350	2500	2000	2000	5000	0	22850
S_2P_1	8000	3000	1500	2500	2000	2000	5000	1600	25600
S_2P_2	13000	3000	1450	2500	2000	2000	5000	2500	31450
S_3P_0	11000	3000	1400	2500	2000	2000	5000	0	26900
S_3P_1	7000	3000	1500	2500	2000	2000	5000	1600	24600
S_3P_2	12000	3000	1450	2500	2000	2000	5000	2500	30450

B. Overhead Cost (Tk/ha)

Treatment Combination	Cost for lease of land for 6 months (13% of value of land Tk. 7,00000/year	Miscellaneous cost @ 5% of the input cost (Tk.)	Interest on running capital for 6 months @ 13% of cost/year (Tk.)	Sub Total (Tk.)	Total cost of production (Tk./ha) [Input cost (A)+overhead cost (B)]
S_1P_0	45500	1650	5915	53065	**80065**
S_1P_1	45500	1650	5915	53065	**71615**
S_1P_2	45500	1650	5915	53065	**79465**
S_2P_0	45500	1650	5915	53065	**75915**
S_2P_1	45500	1650	5915	53065	**78665**
S_2P_2	45500	1650	5915	53065	**84515**
S_3P_0	45500	1650	5915	53065	**79965**
S_3P_1	45500	1650	5915	53065	**77665**
S_3P_2	45500	1650	5915	53065	**83515**
S_1P_0	45500	1650	5915	53065	**80065**

Appendix IVX: Agro-Ecological Zone of Bangladesh



Location of Experimental field