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Effect of organic and inorganic regimes on growth, production and quality characteristics of cauliflower

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Increasing crop yield through balanced use of fertilizers in combination with organic acids is a need of the time to limit the use of costly chemical fertilizers as well as to minimize the environmental pollution in Pakistan.This trial aimed to investigate the benefits of organic and inorganic regimes application on growth, yield and quality of cauliflower. In this study, organic (Farmyard manure (FYM), Poultry manure (PM), Spent mushroom Compost (SMC) at the rate of (15:3:6 t ha^{-1}), inorganic (NPK @ 100:60:60 kg ha^{-1}) regimes and Cauliflower cultivars (Kohat local, Hollywood, Lucky, White beauty and Pearl) were used. The organic regime showed highest value for number of leaves $plant^{-1}$, leaf area, chlorophyll content, plant height, curd diameter, curd weight, curd dry matter content and total yield of the cauliflower. Regarding cultivars, the minimum days to germination, maximum number of leaves $plant^{-1}$, chlorophyll content, curd diameter, curd weight, curd dry matter content and total yield were recorded in cultivar Lucky. While cultivar White beauty showed maximum leaf area, plant height and curd pH. From the results it is concluded that cultivar Lucky performed well in organic regimes and recommended for better quality and high yield production in Peshawar valley.

Keywords: Soil fertility management, Nitrogenous fertilizer, Disease resistance, Caleus, Compost, Brassicaceae

INTRODUCTION

Soil fertility management is the key to sustainable crop production. Soils across the globe are losing their fertility and productivity due to their intensive use (Tiemann et al., 2014).

Use of nitrogenous fertilizers is particularly contributing towards water pollution through nitrate leaching (Moss, 2008). Nitrous oxide emissions are the major contributor towards greenhouse gases whose share is continuously rising, thereby, contributing to intensify the climate change (Pachauri et al., 2014; Velthof et al., 2014; Nassar, 2015) .Cauliflower (Brassica olereaceae L. Botrytis) belongs to the mustard family Brassicaceae and is cultivated for its white curds as edible part. The name of cauliflower is derived from two latin words, Caulus means cabbage and floris mean flower. These flowers contains many nutrients like phosphorous, calcium, vitamin A and C. The current cultivated area of cauliflower in Pakistan is 12689 ha while its production is 220637 tons. Likewise, in Khyber Pakhtunkhwa (KP) the cauliflower is cultivated on an area of 1360 ha^{-1} with a total production of 15631 tons. The average yield of cauliflower in 11.4 tons ha^{-1} (MINFSR, 2013-14).

Cauliflower can be grown on many types of soil but fairly deep loamy and well-drained soil is good for high quality and yield. The best soil pH for cauliflower is 6-6.8 because its sensitivity to acidity (Islam et al., 2014).It is the observable fact that the nature recycles its ingredients over

suitable cycles. e.g. water cycle, nitrogen cycle etc. Like this phenomenon organic matter also recycled i.e. the microorganisms recycled the organic matter back into the nutrients by decomposition and these nutrients are then used by plants for their nourishment. Organic fertilizers change the soil environment and improve the soil structure (Yosefi et al., 2011). Due to organic fertilizers the nutrients are available to plant and hence the growth rate and development of the plant increases. Organic fertilizer increase the resistivity to the disease and more productive as compared to those plants which are grown in artificial fertilizers (Worthington, 2001). In organic farming the farmers uses farmyard manure (FYM), poultry manure (PM), mushroom compost (MC) which are recycled on proper process and produce beneficial manures enhancing the accessibility of the important nutrients to the plants and improve the environment. In organic fertilizers, the addition of rock phosphate (Alkanda et al., 2005) and ash (Mbah and Npkji, 2009) enhance the nutrients in the fertilizers. The organic fertilizers helps in providing essential nutrients to plants, cleaning environment, safe for ecosystem and have no harmful effect. Similarly it increases soil health and enhancing physical and chemical properties of the soil. Organic fertilizers reduce the negative effect of inorganic fertilizers (Hartatik and Widowati, 2013).

Nitrogen is the main identifiable nutrients for its presence in the structure of protein molecule Nitrogen plays a vital role in the formation of plant constituents through the action of enzymes (Khalid, 2013). Curd initiation and development of cauliflower can increase with the application of phosphorus fertilizers. Phosphorus is the second main element for increasing the yield of cauliflower (Damchak and Smith, 1990). Phosphorus fertilizers with the addition of organic manures increase the phosphorus uptake by plants, solubility of phosphate compounds increased (Yosefi et al., 2011). Like phosphorus, the potassium is also the important nutrient for yield and dry matter content of cauliflower. With the application of potassium fertilizers with phosphorus and nitrogen, the increase of yield and vitamin C was observed in cauliflower (Ying et al., 1997).

Farmers mainly rely on the use of inorganic fertilizers for increasing the yield of these crops. Due to population pressure we cannot ignore the importance of these crops, and also we cannot compromise on soil fertility and quality. We hypothesized that organic and inorganic regimes in combination with commercial fertilizer may increase crop yield without degrading quality of soil.

MATERIALS AND METHODS

Experimental site and Materials

This research was conducted at Agriculture Research Institute Tarnab farm, Peshawar (longitude 710 ^{o}50, latitude 340 ^{o}01),, Pakistan. The site is located at the altitude of 400 m above sea level and having cool climate in winter and warm to hot in summer. Mean annual rainfall was range from 380-550 mm during the experimental period 2018-2019 with slightly summer dominance. Before the application of fertilizers and transplantation, five different soil samples were collected from the experimental area by using auger with the depths of 0-15 and 15-30 cm for further investigation. Soil samples were taken in the plastic bags, labeled and were analyzed for EC, Lime, pH, soil texture, organic matter contents and total N, P, K. All the investigation were carried out in soil science laboratory at ARI Tarnab, Peshawar. After analysis the following data were calculated EC (0.26 d ms^{-1}), Lime (14.27%), pH (7.8), organic matter (0.81%), Nitrogen (0.051%), phosphorous (mg kg^{-1}), and potassium (mg kg^{-1}).

Experimental design and Treatments

The experiment was carried out using Randomized Complete block Design (RCBD) with split plot arrangement. Organic regimes (Spent Mushroom Compost + Poultry manure + Farm yard manure (6: 3: 15 t ha^{-1}) and inorganic (NPK=100: 60: 60 kg ha^{-1}) fertilizers were applied to different cultivars (Kohat (local), Hollywood, Lucky, White Beauty, and Pearl).Cauliflower was established in the plastic tunnel. Pots were filled with recommended media and then seeds were sown after that irrigation were done. The seedlings were ready within 4-6 weeks for transplantation after sowing. When the seedlings attained a height of 15 cm they were transplanted to the well prepared field bed**.** The regimes were assigned to the main plot, while the cultivars were assigned to the sub plot. The treatments were replicated three times and each replication was divided into the two main plots having 15 m^{2} (3m x 5m) area of each. Every main plot was divided into five subplots having 3m x 1m area.

Data Collection

Following variables were studied during experimentation.

Days to germination

For days to germination, days from date of sowing were recorded to at least 50 % germination in each subplot and their average was calculated for further statistical analysis.

Number of leaves plant^{-1}

At the end of the season, randomly five plants were selected in each subplot and their numbers of leaves^{-1} were recorded by counting and then their averages were calculated.

Leaf area (cm^2)

Five plants were randomly selected in each subplots and leaf area with the help of leaf area meter and their mean was calculated.

Determination of Chlorophyll content (SPAD)

SPAD meter was used for determination of leaf chlorophyll content. For this purpose leaves from five randomly selected plants were taken and their chlorophyll content was recorded and their average were calculated.

Determination of Plant height (cm)

At physiological maturity, plant height of five randomly selected plants was measured with the help of measuring tape and then their average were determined.

Determination of Curd Diameter (cm)

The diameter of the cauliflower curd was measured at the middle in two pole portions of the selected marketable curd which was taken from five randomly selected plants in each subplot by using measuring tape and then their average was calculated.

Curd Weight (kg)

Weight of the five randomly selected plants curds were measured by using digital scale and then calculated their average. The weight was first taken in grams (g) and then converted into kilogram (kg).

Determination of Curd pH

Curd pH was find out through pH meter. Cauliflower curd pH from randomly selected five plants were noted through curd samples in each subplot.

Determination of Curd dry matter content (%)

Fruit dry matter content were recorded by heat dry method. For this purpose the fruit samples from five randomly selected plants of each subplot was collected and then put it on a pre-weighted petri dish and then kept the petri dish containing sample in the oven for 24 hours at 100°C. After 24 hours the sample were taken from the oven and again measured their weight and then determined curd dry matter content with the help of following formula.

$$Curd\ dry\ matter\ content = \frac{\mathrm{C} - \mathrm{A}}{\mathrm{B} - \mathrm{A}} \times 100$$

A= Empty Petri dishes weight

B. = Petri dishes weight having fresh sample before drying

C = Petri dishes weight having dry sample after drying.

Determination of Total Yield (t. ha^{-1})

Data for yield was noted in each plot. Then total yieldha^{-1} for all treatments were calculated by using the following formula.

$$Total\ yield\ (t.ha-1) = \frac{\text{Total yield per plot}}{\text{Plot area}} \times 10000$$

Statistical Analysis

Statistical analyses were performed using the Statistix 8.1 software. The effect of the productivity and quality criteria was carried out by using a general linear model, bivariate analysis of variance (BIANOVA). Differences among averages were determined according to LSD test at P ≤ 0.05 (Jan et al., 2009). Plots were made by sigma plot 10.0.

RESULTS AND DISCUSSION

Days to Germination

The two-way analyses of variance (ANOVA) showed significant (p< 0.005) effects of cultivars on days to germination of cauliflower, whereas regimes and interaction of cultivars and regimes had non significant effect on days to germination (Table 1). In cultivars, the minimum days (6.33 days) to germination was observed in cultivar lucky. While maximum value of days to germination was recorded for the cultivar Holloywood (9.0 days) that was at par with White beauty and Pearl cultivar (Figure 1). The cultivar Lucky took minimum days to germination because this cultivar was genetically early germinating cultivar which complete their life cycle early as a result takes minimum days to complete their life cycle (Kumar et al., 2002).

Number of leaves plant^{-1}

The two-way analyses of variance (ANOVA) showed significant (p< 0.005) effects of cultivars and regimes was significantly affected by number of leaves plant^{-1}, while their interaction of cultivars and regimes had non-significant effect (Table 1).In regimes, the maximum number of leaves^{-1} (22.53) was produced by organic regimes as compared to inorganic regime (21.60). While in cultivars, the highest numbers of leaves^{-1} (25) was recorded on the cultivar lucky followed by the cultivar Kohat (local) (22.67). The minimum numbers (19.50) of leaves^{-1} was observed on the cultivar white beauty (Figure 1). In case of regimes the maximum number of leaves^{-1} was noted in organic regimes because the application of organic manures improves the vegetative growth and yield of the cauliflower. The organic manures improve the quality of soil, availability of nutrients to the plants and also increase the soil physical and biological properties (Mahmoud et al., 2009). The main reason of the availability of essential nutrients in the soil is the biological properties which enhance the growth and development of roots and plants. These biological properties of the soil were increased with the application of organic fertilizers (Golabi et al., 2004). Organic manures also increase the soil structure and porosity which improve the capability of the soil to use more water and thus improves the vegetative growth of the crop (Brandy and Weil, 2010). These results are similar with the results of Simarmata and Setyowati (2016) who concluded that the number of leaves plant^{-1} was increased with the application of organic manure. The production of more numbers of leaves on the cultivar Lucky might be due to many factors such as genetic makeup of the cultivars, efficient nutrients uptake and the adaptability to climatic condition (Aditya *et al*., 1989). Similar results was noted by Islam *et al*. (2014) who concluded that there were a significant variation in cauliflower cultivars with respect to number of leaves plant^{-1}.

Leaf area (cm^2)

The two-way analysis of variance (ANOVA) showed significant (p< 0.005) effects of cultivars and regimes on leaf area, while their interaction showed non- significant effect on leaf area (Table 1).The organic regimes attained maximum (1005.34 cm^2) leaf area as compared to inorganic regime (958.90 cm^2). In case of cultivars the maximum (1179.73 cm^2) leaf area was observed on cultivar White beauty followed by the cultivar Lucky (1041.97 cm^2). While the minimum leaf area (868.32 cm^2) was recorded on the cultivar Pearl (Figure 1). By using the organic fertilizers the soil physical and biological properties improved due to which the availability of essential nutrients in the soil increased (Yadav et al., 2007) and thus increase the growth, yield of the plant (Farahzety and Aisah, 2013) and quality of the crop (Singh et al., 2013). The use of organic manure can improve the growth and yield of some vegetable crops (Jahan et al., 2014). Tomato leaf area increase by poultry manure application (Isitekhale et al., 2013). Environmental factors, soil factor and genetic factors are responsible for the variation among different cultivars of cauliflower regarding leaf area (Ahmad et al., 2003).

Chlorophyll content (SPAD)

The two-way analyses of variance (ANOVA) showed significant (p< 0.005) effects of cultivars and regimes on chlorophyll content, while their interaction was non-significant (Table 1). In regimes the organic showed maximum chlorophyll content (57.01 SPAD) and inorganic regime attained minimum chlorophyll content (55.26 SPAD). In case of cultivars, the maximum chlorophyll content (62.50 SPAD) was observed in cultivar Lucky followed by White beauty (58.80 SPAD) and the minimum chlorophyll content was noted in cultivar Kohat local (50.18 SPAD) (Figure 1). The maximum chlorophyll content observed in organic regime might be due to the high impact of organic fertilizers on carbohydrates, protein, amino acids, chlorophyll, vitamin C and chlorophyll content of the plant (Islam et al., 2014). The organic manure produce maximum chlorophyll content because of the nitrogen present in the organic manures which is the main component of protoplasm and chlorophyll and also form the growth modifiable substances (Yadav et al., 2007).

The same results were observed by Velmurugan et al. (2008) and Kachari and Korla (2009). The micro and macro nutrients present in the organic manures play a great role in the plant nutrition which is essential for the growth and development of the plant (Attememe, 2009). In cultivars the maximum chlorophyll content was observed on cultivar Lucky because of the genetic variation of the cultivar, maximum numbers of leaves, maximum leaf length and several other factors like the adaptability of the cultivar in the Peshawar climate and the availability of the favorable environmental condition (Chubey et al., 2006).

Table 1: Means Square value of growth and yield attributes of cauliflower as influenced by regimes and cultivars

SOV	DF				Mean Square (MS)						
		DTG	NOLP	LA	CC	PH	CD	CW	CpH	CDM	TY
Replication	2	0.700^{ns}	0.933^{ns}	1904.821^{ns}	2.740^{ns}	8.400^{ns}	0.732^{ns}	0.024^{ns}	0.002^{ns}	0.036^{ns}	0.251^{ns}
Regimes (R)	1	0.033^{ns}	6.533*	16169.480**	22.881*	76.800*	57.408**	0.133*	0.003^{ns}	0.888**	6.778**
Error I	2	0.233	0.133	124.219	0.508	1.200	0.070	0.004	0.000	0.020	0.202
Cultivars (C)	4	8.033**	24.550**	100959.863**	137.794**	161.250**	36.376**	0.859**	0.089**	5.249*	33.879*
R x C	4	0.367^{ns}	2.283^{ns}	87.966^{ns}	0.584^{ns}	5.550^{ns}	1.831^{ns}	0.050^{ns}	0.029^{ns}	0.003^{ns}	0.543^{ns}
Error II	16	0.550	1.117	314.712	0.710	13.425	1.730	0.022	0.016	0.023	0.335
Total	29										

DTG: Days to germination, NOLP: Number of leaf plant^{-1}, LA: Leaf area, CC: Chlorophyll content, PH: Plant height, CD: Curd diameter, CW: Curd weight, CpH: Curd pH, CDM: Curd dry matter and TY: Total yield
**=LSD≤0.01, *=LSD≤0.05,ns:Non significant

Plant height (cm)

The two-way analyses of variance (ANOVA) showed significant (p< 0.005) effects of cultivars and regimes on plant height, while their interaction was non-significant effect (Table 1).In regimes the maximum plant height (65.60 cm) was observed in organic regime and the minimum plant height (62.40 cm) was recorded in inorganic regime. In case of cultivars, the maximum plant height (72.00 cm) was noted on cultivar White beauty followed by cultivar Lucky (66.50 cm).The cultivar lucky and white beauty was statistically at par. The minimum plant height (60.00 cm) was observed on cultivar Kohat (local) (Figure 1). Increase in the vegetative growth of cauliflower plant may be in response of organic manure which provide the steady supply of nutrients (Ghuge et al., 2007) and favorable soil structure as result the growth of vegetables crop increase (Sharma and Bhalla, 1993). The application of organic manure such as farmyard manure improve the soil properties like soil porosity, soil water capacity and soil fertility that increase plant growth (Karlen and Camp, 1985). These results are similar with the findings of Shafiee Zargar (1996) who concluded that the application of farmyard manure increases the plant height of cucumber. The application of farmyard manure with urban waste compost increases the height of wheat plant (Ebrahim et al., 2010).

Curd diameter (cm)

The two-way analyses of variance (ANOVA) showed significant (*p*< 0.005) effects of cultivars and regimes on curd diameter, while their interaction was non-significant effect on curd diameter of cauliflower (Table 1).Mean data presented in Figure 1 showed that the maximum curd diameter (24.95 cm) was observed on the organic regime, while the minimum curd diameter (22.18 cm) was recorded on inorganic regime. In cauliflower cultivars the maximum curd diameter (27.15 cm) was recorded on the cultivar Lucky followed by the cultivar White beauty (24.82 cm). While the minimum curd diameter (20.80 cm) was observed on the cultivar Kohat (local). The organic manure application could increase the availability of macro and micro nutrients in the soil due to which the yield of several vegetables have been increased (Ghuge et al., 2007). Similar type of finding was reported by Srimathi (2013). They concluded that the application of organic manure with bioregulators increased the curd diameter.

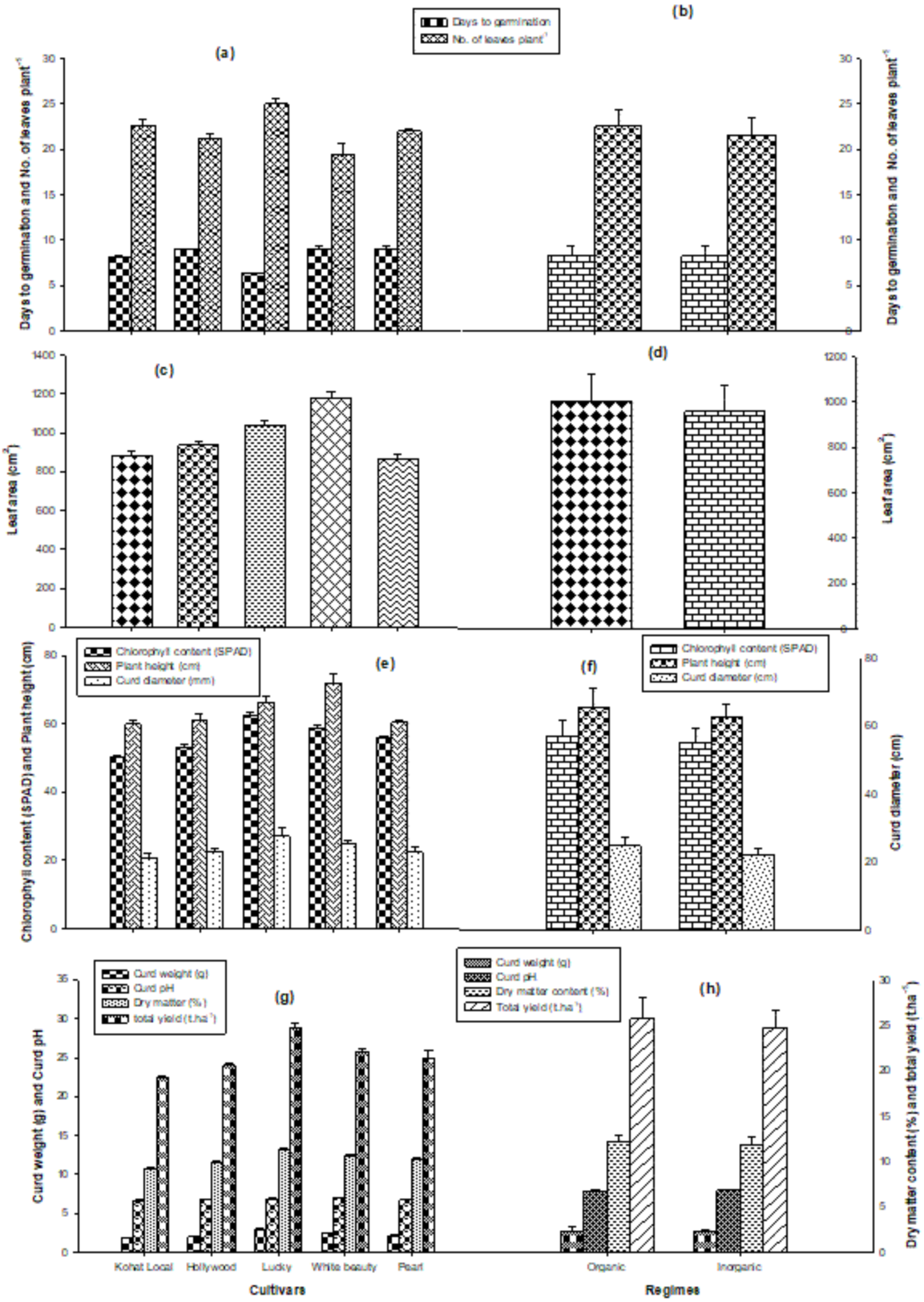

Figure 1: Growth, yield and quality attributes of cauliflower as influenced by cultivars and different regime

The increase in vegetables yield might be due to the existence of macro and micro nutrients, vitamins, enzymes, antibiotics and growth hormones in organic fertilizers (Sharma et al., 2004). The maximum curd diameter on cultivar Lucky was due to the genetic probability, which has greatly affected the growth of the plant. Also the maximum curd diameter was due to the maximum leaf area as result of which more chlorophyll content present in the cultivar due to which more photosynthesis occurred. Several other factors are also responsible for the vegetative and reproductive growth of the plant i.e. soil condition and environmental factors (Meena et al., 2010). According to Sharma *et al*. (2006) that different cauliflower cultivars have different curd diameter because of the variation in their genetic characteristics.

Curd weight (kg)

The two-way analyses of variance (ANOVA) showed significant ($p< 0.005$) effects of cultivars and regimes on curd weight, while their interaction was non-significant effect on curd weight of cauliflower (Table 1).In regimes the maximum curd weight (2.35 kg) was observed on organic regime while the minimum curd weight (2.22 kg) was recorded on the inorganic regime. In case of cultivars the maximum curd weight (2.85 kg) was recorded on cultivar Lucky followed by the cultivar white beauty (2.48 kg). The minimum curd weight (1.92 kg) was observed on cultivar Kohat local (Figure 1). The organic manure influences the weight of the curd by contributing directly to yield of the crop due to the supply of nutrients which improve soil physical and biological properties (Sharma et al., 2005). These nutrients are also essential for nucleotides, protein, chlorophyll and enzymes which play a vital role in many metabolic processes as result the vegetative and reproductive growth of the plant increases. Similar results were also reported by Singh (2002) in cabbage, Manivanan and Singh (2004) in broccoli and Krezel and Koota (2004) in Chinese cabbage. Bohyan et al. (2011) reported that there are many nutrients exist in the organic manure like farmyard manure which enhance the photosynthesis rate of the plant and helps to increase the yield of the plant. The maximum curd weight in cultivar Lucky might be due to genetic differences and the adaptability of the cultivar to the local climatic condition or more nutrients uptake by the cultivar. The maximum curd weight of the cultivar Lucky might also be due to the maximum diameter, maximum leaf length and maximum leaf area of the cultivar and the translocation of the photosynthetic products to the fruit (sink) which is curd (Singh et al., 2005).

Curd pH

The two-way analyses of variance (ANOVA) showed significant ($p< 0.005$) effects of cultivars and regimes on curd pH, while their interaction was non-significant effect on curd pH of cauliflower (Table 1).While the regimes and the interaction of regimes and cultivars had non-significant on curd pH. In cultivars the maximum pH (7.00) was observed in cultivar White beauty followed by the cultivar Lucky (6.82), while the minimum pH was recorded in cultivar Kohat (6.69) (Figure 1). The maximum pH was observed for cultivar Lucky which might be due to genetic diversity in the constituent of the cultivar, the environmental factors, soil situation and the acidity of the cultivar (Islam et al., 2014). Kumar et al. (2010) also recorded variation in curd pH of different cauliflower cultivars.

Curd dry matter

The two-way analyses of variance (ANOVA) showed significant ($p< 0.005$) effects of cultivars and regimes on curd diameter, while their interaction was non-significant effect on curd diameter of cauliflower (Table 1).In case of regimes the maximum curd dry matter content (12.13%) was recorded on organic regime, while the minimum curd dry matter content was observed on inorganic regime (11.79%).In cultivars the maximum curd dry matter content (13.24%) was recorded on cultivar Lucky followed by the cultivar White beauty (12.43%). While the minimum curd dry matter content (10.76%) was noted on cultivar Kohat local (Figure 1). The maximum dry matter content of cauliflower might be due to the presence of all the micro and macro nutrients present in the organic fertilizers which increase the photosynthesis process due to which the weight of the plant increased and the growth and development of the plant increased by improving the size and volume of the cell in the plant (Farahzety and Aisshsah, 2013). The increase in dry matter content of the cauliflower curd might be attributed due to the presence of all nutrients in organic fertilizers as compared to other fertilizers (Jahan et al., 2014). In cultivars the maximum curd dry matter content was recorded on cultivar Lucky because of many factors such as maximum diameter of the curd, maximum weight of the curd and many other factors such as genetic makeup and

environmental factors (Wurr et al., 1996). Our results are similar with the findings of Islam et al. (2014) who reported that different cauliflower cultivars have different dry matter content due to their genetic variation

Total Yield (t.ha^{-1})

The two-way analyses of variance (ANOVA) showed significant ($p< 0.005$) effects of cultivars and regimes on total yield of cauliflower, while their interaction was non-significant effect on total yield of cauliflower (Table 1). In regimes the maximum total yield (25.69 t ha^{-1}) was observed on organic regimes, while the minimum total yield (24.74 t ha^{-1}) was recorded on inorganic regimes. In case of cultivars the maximum total yield (28.84 t ha^{-1}) was noted on cultivar Lucky followed by the cultivar While beauty (25.81 t ha^{-1}). While the minimum total yield were observed in cultivar Kohat local (22.47 t ha^{-1}) (Figure 1). The maximum total yield of cauliflower was recorded in organic regime which may be due to the presence of organic nitrogen which improves the yield and yield component of the crop. The application of organic fertilizer may significantly increase the availability of macro and micro nutrients in the soil due to which the yield has been increased (Al-Nasir, 2002). Same results were found by Mahendran and Kumar (1998); Ghuge et al. (2007). The increase of yield was attributed due to the existence of macro and micro nutrients, enzymes, antibiotics and growth hormones in organic fertilizers (Sharma et al., 2004). It has been reported that the application of organic manures such as farmyard manure significantly increased the yield of the cauliflower (Dhanasekaran et al., 2007). Similar results were reported by Chinnamuthu and Venkatkrihnan (2001).In cultivars, the cultivar Lucky gave maximum total yield because of the maximum number of leaves, leaf length, chlorophyll content, curd diameter, curd weight and several other factors such as environmental factors and soil factors (Ahmad et al., 2003). The results were in accordance with Sharma et al., (2006) who reported that difference between yield of cauliflower cultivars was due to genetic characters and environmental conditions.

CONCLUSION

The cultivar Lucky took minimum days to germination, maximum numbers of leaves, leaf length, chlorophyll content, curd diameter, curd dry matter content, curd weight, and total yield of cauliflower. The organic regimes attained high yield and best quality cauliflower and is recommended for growing in Peshawar valley. It was concluded that cauliflower cultivar Lucky grown in organic regimes gave better growth, yield components and quality in agro-ecological condition of Peshawar valley.

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CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Mehboob Alam: Principal author, conceived the idea, conducted the research and prepared the 1st draft.
Zawar Hussain: Planned and supervised the research and experiments.
Izhar Ullah: Wrote the article
Muhammad Sajid and Imran Ahmad: Helped in field and reviewing the writing up.
Muhammad Azhar Shah, Intikhab Alam and Muhammad Asif: Helped in field analysis.
Attiq Ur Rehman: Collected the data.

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