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Research Article

Organic manures effect on the bulb production of onion cultivars under semiarid condition

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Abstract

An experiment was carried out to investigate the "Organic manures effect on the bulb production of onion cultivars under semiarid condition". The experimental design was Randomized Complete Block Design with split plot arrangement with three replications. The experiment was consisted of two factors i.e. the organic manures Farmyard manure (FYM), Poultry manure (PM), Spent mushroom compost (SMC), ½FYM + ½PM, ½FYM + ½SMC, ½PM + ½SMC and $^{1}/_{3}$FYM + $^{1}/_{3}$PM + $^{1}/_{3}$SMC were subjected to main plot at the rate of 10 tons ha^{-1} and onion cultivars (Parachinar-Local, Swat-1 and Swat-Local) were maintained to the sub plot. The onion yield and bulb production was significantly affected by both of organic manures application and onion cultivars. The application of organic manure (poultry manure) significantly improved the plant height (79.3cm),bulb diameter (10.2cm), average bulb weight (93.4g) and total yield ha^{-1} (33.9tones), while more number of bulb kg^{-1}(13.1) was noticed with control treatments. The organic manures alone and organic manures combination showed different variation in yield and bulb production of onion crop. In case of onion cultivars, Parachinar-Local cultivar increased significantly the plant height (69.5cm), bulb diameter (7.7cm), average bulb weight (88.1g) and total yield ha^{-1}(27.4tones), whereas the Swat-Local cultivar gave more number of bulb kg^{-1}(11.2). The interaction of organic manure (poultry manure) and onion cultivar (Parachinar-Local) also affected the yield of onion. In case of interaction the organic manure (poultry manure) @ 10 tons ha^{-1} with onion cultivar (Parachinar-Local) suited for the yield of onion crop. From results it is concluded that the onion cultivar (Parachinar-Local) received organic manure (poultry manure) @ 10 tons ha^{-1}showed best result in bulb yield at semi-arid condition.

Keywords: FYM; Onion; PM; Parachinar local; Swat 1; Swat Local; SMC

Introduction

Onion (*Allium cepa* L.) is one of the important vegetable crops, belongs to family *Amaryllidaceae* and sub family *Allioideae*. It is cultivated in the world widely especially in Asia. Onion is grown in Pakistan as commercially vegetable crop. The onion (*Allium cepa* L.) is used on daily basis as a condiment either as mature bulb in salad and also for preparation of other different dishes

or as green leaves [1]. Onion is cool season crop and it is also biennial, cross pollinated crop mostly and shallow rooted crop. The onion produced wide range of bulbs depending on the varieties. The bulbs having various sizes such as small, medium and large and also having different colors i.e. white, yellow and red and also different shapes such as flattened, round and globular. The onion is categorized in short days and long days which is dependent on day length requirement. The onion which required a day length of 11.15 hours are short day and which required 14 hours or more for bulb production are ling day. For bulb and seed production it requires relatively high temperature and long photoperiod [2]. The pungency in the bulb is due to presence of volatile oil (allyl propyl disulphide) [3]

Onion is grown on different types of soil but they grow best on fertile soil which contain humus and also well drained. In high acidity condition it is very sensitive and produces more yield with optimum pH range (5.8-6.5). It is grown in other types of soil also such as clay, sandy loams and mucks. Onion seedlings are transplanted to the field by keeping the row to row distance (30cm and plant to plant distance (15cm) [4]

The onion total production in Pakistan is (1660.8) tons and area under cultivation in Pakistan is (126.0 ha). In Khyber Pakhtunkhwa the onion total average yield is (16.6) tons per hectare and area of cultivation in KP is (11.1) hectare with a production of (187.5) tons [5]

Onion is a high valued cash crop next to chili due to high cost of production. Presently it price are high and consumers cannot affordable it and there are so many problems in marketing to the farmers and they do not have better profits from its cultivation. Another reason is that farmers also paid more prices for buying fertilizers. Normally excessive amount of chemical fertilizers are applied to vegetables crops for more production [6]. Whenever chemical fertilizers applied to soil it produce several harmful effects to human health and also to environmental condition. The synthetic fertilizers are lost from due to evaporation such as N, P and K and also leach down into the soil. It is also produced many environmental hazards such as environmental pollution [7]. Soil structure affected by more usage of inorganic fertilizers, therefore organic manures used as alternative to chemical fertilizers for improving soil structure [8].The organically and inorganically fertilized plants were both had higher uptakes of N, P and K then unfertilized plants [9].

Organic manures i.e. Spent mushroom compost which contains materials such as humus, essentials Nutrients in different amounts i.e. Nitrogen 0.7%, phosphorus 0.3% and potassium 0.3%. By adding spent mushroom compost increase the pH of soil because it is alkaline in nature due to presence of chalk content [10].Organic matters are very important for better plant health and also most important component of the soil. More depletion occurs in soil organic matters of agricultural soil due to intensive cultivation about last 50 years which result in degradation of soil structure. The organic manure when applied to the soil had more porous and buffering capacities which help in plant growth and also add more organic matter to the soil which provided more nutrients to the plant roots [11]. By this reason the farmers started organic farming systems in which no use of synthetic fertilizers and pesticides [12].

Organic manures enhance the different properties of soil i.e. physical, chemical and biological and also increase the moisture holding capacity of soil which resulted more in maintaining the quality of crop production and crop production [13]. The organic fertilizers hold plant nutrients which promote enzymes and hormones, besides plant

nutrients make them necessary for enhancement of soil fertility and production [14]. By the application of Organic manures to fruits, vegetables and food crops, we should take some precautions. Before using organic manures we should want to check it by different ways. To avoid using fresh manure of animals that contains different pathogens this harmful to plants. To kill pathogens that present in compost manure and to applied the manure in best time to avoid excessive leaching and runoff [15].

Organic manure and biofertilizers mixture increased the yield and provide more nutrients to onion tuber [16]. Several experiments were conducted such as in one experiment the effect of animal manure at rate of 20, 40, 60 t/ha along with NPK (75: 50: 100 kgha^{-1}) and also applied of both fertilizers in mixture applied to onion crop. The researchers concluded from the experiment that the onion crop which received animal manure gave more yield as compare with onion crop where applied NPK fertilizers [17]. The growers got more profit by organic farming system. In organic farming less cost of production required and it is reduce the chance of environmental pollution. It is also improved the soil structure, enhance different activities of soil organisms which are useful to plants. The vegetables and fruits etc produced by organic farming are good for human health [18].

Keeping the above points in view the research study was conducted at Horticulture Research Farm, The University of Agriculture Peshawar, to know the effect of different organic manures on yield of onion cultivars.

Materials and methods

Preparation of organic media

For the preparation of organic media the organic materials were collected from different centers such as poultry manure from poultry farm, spent mushroom compost from mushroom research centre and farmyard manure from Diary Farm situated in the University of Agriculture Peshawar. Seven different media were prepared, firstly prepared three media of farmyard manure (FYM), poultry manure (PM) and spent mushroom compost (SMC) alone at the rate of 10 tons ha^{-1}. The four different mixtures of organic media were also made at the rate of 10 tons ha^{-1} i.e. ½FYM + ½PM, ½FYM + ½SMC, ½PM + ½SMC and $^{1}/_{3}$FYM + $^{1}/_{3}$PM + $^{1}/_{3}$SMC. The organic manures were applied the field about one month before the transplantation of onion seedlings. After field preparation the seedlings of onion cultivars were transplanted in the field.

Experimental design

The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement. The treatments were 24 and all treatments replicated three times. The following is the detail of treatments of the experiment (Table 1).

Soil analysis

For soil analysis the soil samples were collected randomly from three different location of experimental field at the depth of 25 cm before organic fertilizers application, the physio-chemical analysis was tested in soil department of the Agriculture University of Peshawar (Table 2).

Data recording

Data on plant height was recorded in centimeters at the end of the growing seasons through measuring tape by selecting five plants randomly from each plot in each replication and then averaged. Bulb diameter of onion was measured through vernier caliper by selecting five plants randomly from each treatment and then average was worked out. For average bulb weight five selected bulbs were weighted in each plot and then average was worked out. Bulb from each treatment was randomly selected and selected bulbs were weighted with digital balance and the average number of bulbs per kg of each treatment was calculated. Total yield was

noted by weighting the harvested bulbs from each treatment. The total yield was noticed in tons hacrtare^{-1} by the following formula;

$$\text{Total yield (tons ha}^{-1}) = \frac{\text{Bulb yield plot}^{-1}}{\text{Area of plot (m}^2)} \times 10{,}000 \text{ m}^2$$

Table 1. Treatments of the experiment

Factor A (Organic manures) (10 tons ha^{-1})			
Main plot			
O1	Control	**O5**	½FYM + ½PM
O2	Farmyard manure (FYM)	**O6**	½FYM + ½SMC
O3	Poultry manure (PM)	**O7**	½PM + ½SMC
O4	Spent mushroom compost (SMC)	**O8**	$^1/_3$FYM + $^1/_3$PM + $^1/^3$SMC
Factor B (Onion cultivars)			
Sub plot			
C1	**C2**	**C3**	
Parachinar-Local	Swat-1	Swat-Local	

Table 2. Soil analysis of experimental site at 25 cm depth

Before transplantation						
Determination	**Nitrogen (%)**	**Phosphorous (mg kg^{-1})**	**Potassium (mg kg^{-1})**	**Organic matter (%)**	**pH**	**Texture Class**
Quantity	0.048	8.99	111	o.81	7.5	Clay Loam
After harvesting						
Control	0.031	6.01	90.1	0.60	7.3	Clay Loam
With Organic Manures	0.062	13.6	131	1.20	6.9	Clay Loam

Statistical procedure

The data regarding with different variables were allotted to the statistical variance of analysis to observe the variation between different treatments and also to know the effect of interaction on onion crop. MSTATC (Michigan State University, USA) and Statistical analysis software was used for ANOVA and LSD values [19].

Results and discussion

Plant height (cm)

The plant height mean values showed in (Table 3) showed that the organic manures, onion cultivars and their interaction had significantly plant height. The maximum plant height (79.3cm) was obtained from the plants applied poultry manure, closely followed by the plant height (72.3cm) in plant received organic media ½Farmyard manure + ½poultry manure whereas the minimum plant height (55.3cm) was observed in control treatment. The plant height for three different onion cultivars in (Table 4) reported that the highest plant height (69.5cm) was measured in cultivar Parachinar-Local, followed by plant height (65.6cm) in cultivar Swat-1, while the lowest plant height (63.4) was recorded in cultivar Swat-Local. The interaction of organic manures and onion cultivars significantly

affected the plant height (Table 5). In case of interaction the more plant height (85.5cm) was observed in Parachinar-Local cultivar received the poultry manure, closely followed by the plant height (78.2cm) in Swat 1 cultivar treated with poultry manure. The minimum plant height (51.4cm) was noticed in cultivar swat-local with control treatment. In case of cultivars the difference among the onion cultivars might be due to the adoptability of cultivar to the specific environmental condition and also by the genetic variation of onion cultivars [1]. Similarly [20] studied six onion cultivars in which best result was obtained in Swat local and Faisalabad which gave the maximum plant height (55.0 cm). The plants which received the poultry manure had tallest plant height then the plants which not treated with poultry manure [21]. Poultry along with vermin compost improve the growth of okra [22]. Organic manures showed significant effect on the plant height and number of fruits per plant in chilli crop [23].

Bulb diameter (cm)

The results presented in (Table 3 & 4) showed that the organic manures and onion cultivars had significantly affected the bulb diameter of onion, where the interaction had also significantly affected. The highest bulb diameter (10.2cm) was noted with the application of organic manure poultry manure, followed the bulb diameter (8.4cm) by the application of organic manure ½Farmyard manure + ½poultry manure, while the lowest bulb diameter (4.8cm) was observed in the plants with control treatment. Among the onion cultivars highest bulb diameter (7.7cm) was recorded in cultivar Parachinar-Local, followed by the bulb diameter (6.7cm) in cultivar Swat-1. In case of cultivars the lowest bulb diameter (6.1cm) was noted in cultivar Swat-Local. By the combine application of organic manures and onion cultivars gave more bulb diameter (11.0cm) in cultivar Parachinar-Local applied the Poultry manure, followed by the bulb diameter (9.9cm) in cultivar Swat-1 by the application of poultry manure, where the lowest yield (4.2cm) was noticed in cultivar Swat-Local with control treatment(Table 6).The different onion cultivars increased the bulb diameter may be the reason is that the genetic variation occurred among the cultivars and might it also depending on the adoptability of cultivars in specific environment [24]. The cultivar which produce small bulb which may be not absorbed the nutrients and available water in soil [1].

The organic manure i.e. poultry manure improved the bulb diameter by providing more nutrients to the plants. The plants uptake the nutrients to the upper parts of the plants by which the prepared food materials and supplied to plants parts vegetative growth and also increased the bulb development. The results are agreed with [25] who suggested that the poultry manure improve the bulb growth by enhancing the soil properties and overcome the leaching of nutrients from the root zone. The same results was reported by [26] that the organic manures enhanced the physical and chemical properties of onion and improved the bulb diameter.

Bulb weight (g)

The organic manures and onion cultivars significantly affected the bulb weight while its interaction had non-significantly affected (Table 3 & 4). The more bulb weight (93.4g) was recorded in plants with organic media poultry manure, followed by the bulb weight (91.2g) in plants treated with organic media ½farmyard manure + ½poultry manure. The less bulb weight (66.5g) was found in plants received no organic manure. Onion cultivars showed significant response towards organic manures. The maximum bulb weight (88.1g) was found in cultivar Parachinar-Local which was closely followed by the cultivar Swat-1

(83.9g), while the minimum bulb weight (77.3g) was found in cultivar Swat-local.

The improvement in bulb weight may be the role of nutrients which helps in enzymes activation, synthesis of protein, chlorophyll formation, root growth and cell division by the application of organic manures. Organic fertilizers provide the macro and micro nutrients to the plants which help in different situation of plants. By these nutrients the soil structure become fertile and more organic matters are available to the crop, which enhanced the uptake of many nutrients i.e. nitrogen, phosphorus and potassium. The NPK increase the cell division of plant tissues and increase the rate of photosynthesis, the bulb weight and yield increase by the more metabolism of organic matters. The results are in line with [27-32]. By the usage of poultry manure the onion bulb production and yield improved significantly [33]. The organic fertilizers increase the bulb weight by providing the nitrogen to the plants. The nitrogen increases the vegetative growth of plants which results in more number of leaves, length of leaf etc, which later on increase the bulb weight and bulb yield [34]. This discussion also agreed with [26] who reported that onion bulb size and bulb weight increased by organic manures.

Number of bulb kg^{-1}

The number of bulb was affected by the application of different organic manures significantly as well as by different onion cultivars, while the interaction of organic manures and cultivars had non-significant effect on number of bulb kg^{-1} of onion cultivars (Table 3 & 4). The maximum number of bulb kg^{-1}(13.1) was observes with the application of control treatment, while the number of bulb kg^{-1}(12.2) followed in plot receiving the organic media $^{1}/_{3}$FYM + $^{1}/_{3}$PM + $^{1}/_{3}$SMC. The minimum number of bulb kg^{-1} (6.1) was noted in the plants fertilized the organic manure poultry manure. Among the onion cultivars more number of bulb kg^{-1}(11.2) was noticed in cultivar Swat-Local, followed by the number of bulb kg^{-1}(9.6) in cultivar Swat-1. Whereas the minimum number of bulb kg^{-1}(7.9) was recorded in cultivar Parachinar-Local.

The different organic media affect the number of bulb kg^{-1} significantly as well as by the onion cultivars. The organic manure (poultry manure) increases the size/weight of onion cultivars more than other organic media. It is might due to the reason soil got more amount of nutrients which helped in improving the bulb weight as well as size and more food supplied to the for bulb formation and soil structure also improved by organic fertilizers application. The soil porosity increased by adding of organic fertilizers and also provided the best condition for bulb formation and increased the microbial activities in the soil [35, 36].

Total yield (tons ha^{-1})

The results in (Table 3 & 4) showed that the total yield affected significantly by organic manures and onion cultivars, whereas the interaction of organic fertilizers and onion cultivars was found non-significant. The highest yield ha^{-1} (33.9 tons) was recorded in plants received the organic media poultry manure, closely followed by yield ha^{-1}(30.6 tons) in plants received organic media ½farmyard manure + ½poultry manure. The lowest yield ha^{-1} (19.2 tons) obtained from the plants with control treatment. In Cultivars the highest yield ha^{-1} (27.4tons) was recorded in parachinar-local at par with the yield ha^{-1}(25.6 tons) was recorded in swat-1. The lowest yield ha^{-1} (23.7 tons) was noticed in cultivar swat-local.

Table 3. Plant height, bulb diameter, bulb weight, number of bulbs per kg and total yield of onion cultivars as affected by organic manures

Organic Manures	Plant height (cm)	Bulb diameter (cm)	Bulb weight (g)	Number of bulb kg^{-1}	Total yield (tons ha^{-1})
Control	55.3g	4.8f	66.5h	13.1a	19.27g
Farmyard manure	69.7c	7.5c	88.8c	8.1f	27.73c
poultry manure	79.3a	10.2a	93.4a	6.1h	33.96a
Spent mushroom compost	67.6d	6.5d	86.9d	9.1e	24.68de
½FYM+1/2PM	72.7b	8.4b	91.2b	7.1g	30.63b
½FYM+ ½SMC	61.3ef	5.9de	78.3f	11.0c	25.06d
½PM+½SMC	62.8e	6.0de	83.1e	10.1d	20.89fg
$^1/_3$FYM+$^1/_3$PM+$^1/_3$SMC	60.4f	5.6e	76.7g	12.2b	22.43ef
LSD(5%)	1.72	0.71	1.4439	0.76	2.61

Means followed by the same Letter (s) do not differ significantly from one another at 5 % probability level, using LSD test

Table 4. Plant height, bulb diameter, bulb weight, number of bulbs per kg and total yield of onion cultivars as affected by onion cultivars

Onion cultivars	Plant height (cm)	Bulb diameter (cm)	Bulb weight (g)	Number of bulb kg^{-1}	Total yield (tons ha^{-1})
Parachinar-Local	69.5a	7.7a	88.1a	7.9c	27.40a
Swat-1	65.6b	6.7b	83.9b	9.6b	25.60b
Swat-local	63.4c	6.1c	77.3c	11.2a	23.74c
LSD (5%)	1.08	0.36	1.3537	0.72	1.58

Means followed by the same Letter (s) do not differ significantly from one another at 5 % probability level, using LSD test

Table 5. Interactive effect of organic manures and onion cultivars on plant height

Organic Manure	Parachinar Local	Swat 1	Swat Local
Control	59.2	55.2	51.4
Farmyard manure	71.5	70.4	67.2
poultry manure	85.5	78.2	74.2
Spent mushroom compost	70.5	66.8	65.3
½FYM + ½PM	76.1	71.7	70.3
½FYM + ½SMC	63.9	60.6	59.4
½PM + ½SMC	67.5	61.6	59.3
$^1/_3$FYM+$^1/_3$PM+$^1/_3$SMC	61.5	60.2	59.6

LSD value for organic manures x time of application at 5% level of Probability = 3.04

The increased in yield by the onion cultivars may be due to the fact that every cultivar had own genetic makeup and variation occurred among different genetic characteristics [1]. The increased in yield by organic manures is because of that the organic manures improved the water holding capacity and provide nutrients for a long duration due to

less leaching of nutrients and the nutrients supplied by the inorganic fertilizers more leaching problem occurred [15].
The absorption of N, P, K, Mg and Ca speed up by the usage of organic fertilizers and improved the fertility in the soil and more yield achieved [37]. According to [16, 38-41] that the organic manures along with bio fertilizers gave best results it might be due to activation of plant hormones and more absorption of nutrients from the soil which improved the yield of crop.

Table 6. Interactive effect of organic manures and onion cultivars on bulb diameter

Organic Manure	Parachinar Local	Swat 1	Swat Local
Control	5.4	4.8	4.2
Farmyard manure	8.4	7.5	6.6
poultry manure	11.0	9.9	9.6
Spent mushroom compost	8.4	6.2	4.8
½FYM + ½PM	9.5	8.9	7.2
½FYM + ½SMC	6.3	6.1	5.4
½PM + ½SMC	6.2	5.4	6.4
$^1/_3$FYM+$^1/_3$PM+$^1/_3$SMC	6.4	5.5	4.9

LSD value for organic manures x time of application at 5% level of Probability =1.01

Conclusion and recommendations

From the research it was concluded that the application of organic manures and onion cultivars significantly affected the yield and bulb production of onion crop. The following conclusions were made. Poultry manure improved the plant height (cm), number of bulb kg^{-1}, bulb diameter (cm), bulb weight (g), total yield (tones ha^{-1}) of onion cultivars. The onion cultivar Parachinar-Local gave more response to the organic manure as compare with other onion cultivars in the following variables i.e. plant height (cm), bulb diameter (cm), number of bulb kg^{-1}, bulb weight (g) and total yield (tones ha^{-1}).The application of organic manures effect the yield and bulb production of onion cultivars significantly in semiarid condition. On the basis of above conclusions recommendation were made that organic manure (poultry manure) should be applied to the soil about 1 month before transplantation of onion seedlings while onion cultivar "Parachinar-Local" should be sown with organic manure (poultry manure) @10 tons ha^{-1} under semiarid conditionfor better bulb production of onion crop.

Authors' contributions

Conceived and designed the experiments: M Ali, A Khan & R Ullah, Performed the experiments: M Ali, A Naeem, Analyzed the data: M Ali, MW Khan, Contributed materials/ analysis/ tools: K Khan, S Farooq & K Rauf, Wrote the paper: N Khan.

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