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Effect of Animal Droppings as Manure, Mulching Practices and Time of Planting on Growth and Yield of Onion

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Abstract
In Ethiopia, onions is mainly cultivated in all parts of the country because of ecological suitability. This led to the exploration of possibilities of producing the crop in the south, eastern, westren and northern zones. The objectives were to determine the effect of two different animal droppings as manure sources, different types weed management practices and planting time on the growth and yield of the onions. The experiment was an open field experiment in randomized complete block design (RCBD) and replicated 3 times. The animal droppings used as manures were that of poultry and pig; weed management practices were: (1) sawdust mulch at the rate of 93 tonnes/ha (2) Black polyethylene cover (3) manual weeding (4) weedy check plots. The 3 planting times evaluated were the months of July, June, and August. Data were collected at 2 weekly intervals on growth, yield and weed traits. The result of the experiment showed that the poultry manure performed better than the pig dung on the onions yield in the area. Planting at the month of June was also the best for the studied periods. Furthermore, the use of sawdust as mulch gave the best yield for the onions among mulch materials used. Onions can be grown in Debub area of south eastern Ethiopia provided the results recommended in these study are followed; which are using poultry manure, using sawdust as mulch and planting in the month of June.

Keywords: Pig Dung, Polyethylene, Sawdust, Weed and Venture

Introduction
Onion (Allium cepa L.), is biennial, although it is primarily grown annually for commercial production [1]. It is the second most important vegetable after tomatoes, considering its characteristic flavor [2]. Apart from its culinary virtues, onion bulbs is an important part of this vegetable crop with nearly 98 million tons produced globally [2]. Onion has a high and constant demand, so in agrobusiness it's a top choice to venture into its farming either in large scale or small scale because it generates income to the farmers [3]. In Ethiopia, the bulb onion is mainly cultivated in southern and central Ethiopia zones of Wolaita, Sidama, Gamo, Mizan, wollega, Jimma, Shewa and Gambo [4]. So, it is believed that only the southern and central states produce onions and this age long notion led to the exploration of the possibilities of producing the crop in the south parts of the Ethiopia since research has proven that onion can be grown almost anywhere [5,1]. However, to ensure optimal yield, you will need to take into consideration some important factors like the time of planting.

Generally, onions are best planted between April and August [1,3]. So, ascertaining the best time of planting in Wolaita derived tropical will increase growth and yield thereby enhancing production rate. Furthermore, mineral nutrient management is another factor affecting the crops yield to optimize the quantity and quality of harvested plant produce [5]. Therefore, it is important to consider the animal droppings available as fertilizer source. The application of these animal droppings as manure to meet the nutrient requirement of the onions crops would be very useful in improving productivity [6,7].

Onion among other vegetables due to inherent features such as slow growth, shallow root, small nature, and less area with lack of dense foliage compare poorly with weeds [8]. Weeds has been reported to be a very harmful constraint to production through increaseing the cost of cultivation, reduces the produce yield quality, serving as hosts of insect pests, and pathogen that cause diseases, secretion of harmful phytotoxins by the growth of some weeds [9,10]. Most conventional methods of effective weed control involves high cost and not always available [8]. Hence, there is need for other methods of weed control to ensure maximum production.

Mulching as reported by researchers as having the ability to reduce weeds, conserve moisture, reduce insect pests, regulate soil temperature and consequently increase the crops yield [11,12]. Therefore, this study was formulated with the objective as to determine the use animal droppings manure, weed management practices and planting time differences on the onions growth and yield in Wolaita, South region Ethiopia. An area in the south eastern part of the country in a derived tropical ecology.

Materials and Methods

Study Area

An open field experiment was conducted on the effect of animal droppings, weed management, and planting time on the growth and yield of Onion (Allium cepa L.) in Wolaita. This was conducted during 2021 panting season at the Research Farm of the Department of Crop Science at the Faculty of Agriculture, Wolaita Sodo University (060 29N, 370 51E and 2400m above sea level). This location is regarded as having tropical humid conditions of a bimodal rainfall pattern. The rains normally starts normally in the month of March and extends to the month of October with a dry spell in the month of August. The average annual rainfall in Wolaita ranges from 1155mm to 1955mm with a mean annual temperature of 180C to 300C while that of relative humidity is between 65% to 75% [13].

Materials

The following materials listed below were used for the experiment: red creole onion seeds from local seed suppliers. Droppings of poultry and pigs was were obtained from the Department of Animal Science Battery cage farm the University, while sawdust, black polyethylene, measuring tape and veneer caliper were obtained from the local market in Wolaita town of South region, Ethiopia.

Design and Layout

Field experiment was conducted to measure the growth and yield responses of an onion variety (var: Red Creole®) under two different manure sources which are pig dung and poultry manure at a rate of 20 tons/ha [14]. The experimental design was 4 x 3 x 2 factorial using a randomized complete block design (RCBD) of three replications. Where factor A is the organic manure used viz: poultry manure and pig dung measured at 3 kg per plot that is 20 tonnes/ha. Factor B is the weed management options viz: Black polyethylene mulch, sawdust mulch at the rate of 14 kg/plot (93 tons/ha), manual weeding at four weekly intervals and weedy check. Factor C is the different planting times: June, July and August. The factors were combined to give 24 factorial combinations (2 x 4 x 3). The lands as used were cleared and nursery beds with fine tilt were made. The seeds were sown first in the nursery three days after manure was applied to the nursery beds. The seedlings are allowed to establish for about eight (8) weeks before being transplanted.

Transplanting

The area of land used was 1 m x 1.5 m giving rise to 80 m2. The animal droppings of poultry and pig as manure source were applied two weeks prior to transplanting to enable decomposition. The seedlings were then transplanted at a spacing of 30 cm by 30 cm resulting to twelve (12) plants in each plot.

Data collection

The data collected at two weekly intervals include: plant height, number of leaves per plant, length of the longest leaf, stem girth and bulb weight at harvest. Other weed traits measure are Weed population count: The weed samples were collected using 0.5m2 quadrat, the quadrat was thrown randomly within the plot. Weeds captured in the quadrat were identified and counted. The weeds were classified into broadleaved, grasses and sedges. Weed fresh weight: The weed fresh weight was taken by weighing the harvested weed from the quadrat with sensitive weighing balance.

The Dry Weight: This was taken when the harvested fresh weeds were left in an oven set at a 70 – 800C then weighed afterwards.

Following the same arrangement as in the above experiment, the study set up was done in three different months of June, July, and August. All the data collected were analyzed using ANOVA with Genstat statistical software to test for differences in treatments. The treatment means were separated using Fishers least significance difference at probability level of 5%.

Results and Discussion

Figures 1 presents the total monthly rainfall (mm) in the year 2021. The experiment lasted from June to December 2021. The highest rainfall recorded during the planting season was in August (306.7 mm) after the establishment of the June planting. The rainfall increased from 153.43 mm in the month of July to 306.7 mm in the month of August. A big

decline in rain occurred in the month of October (91.96 mm). There was little amount of rainfall in January, February and December. More frequent rainfall was recorded between the months of April to September. The relative humidity (%) followed closely with rainfall pattern increasing with increase in rainfall (Figure 2). The temperature of the experimental area within the period fluctuates between 20 and 30oC for the minimum and maximum temperatures (Figure 3).

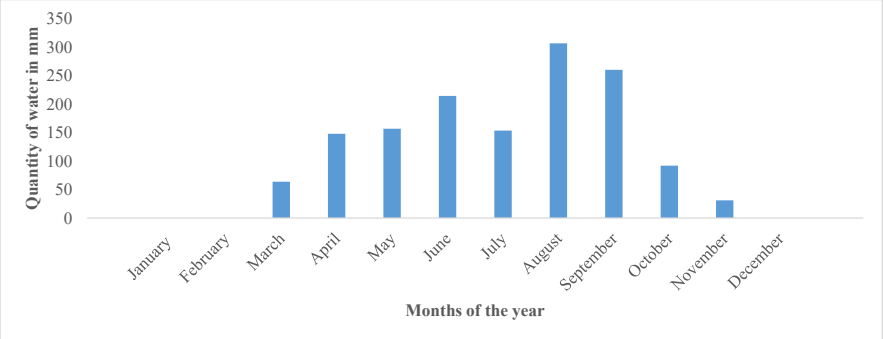

Figure 1: Total Monthly Rainfall (Mm) in the Year of the Experiment. Source: Meteorological Station, Department of Crop Science, WSU

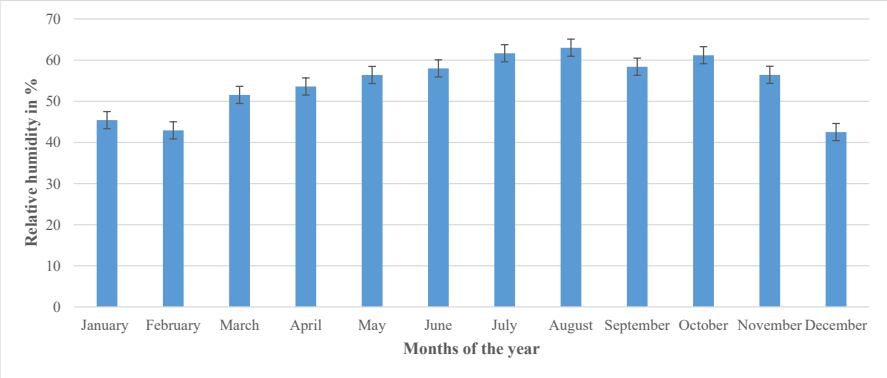

Figure 2: Relative Humidity in Percentage of the Experimental Year. Source: Meteorological Station, Department of Crop Science, WSU

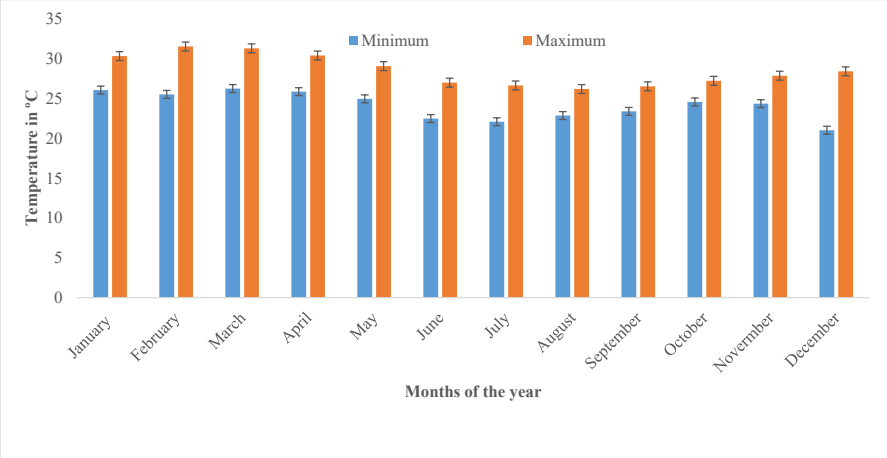

Figure 3: Minimum And Maximum Average Monthly Temperatures in the Year of the Experiment. Source: Meteorological Station, Department Of Crop Science, WSU

Table 1 shows that broadleaved weed species are more dominant than grasses and sedges. Some of the dominant broadleaves were Mimosa pudica Linn, Syndrella nodiflora, Heterotis rotundifolia, Phyllanthus amarus and Oldelandia corymbosia Linn. Among the grasses the most dominant were Oxonopus compressus, Digitaria eriantha and Andropogan gayanus while Cyperus deformis and Mariscus alternifolius dominated in sedges. Table 2 shows the main effect of weed management options on height of the plants, leaf length, leaves produced together with the stem girth of the Allium cepa L. at 2, 4, 6 and 8 weeks after transplanting. At 2 WAT, weedy check plots produced crops that differed significantly ($p<0.05$) on the number of leaves. Significantly, the weeded plots produced higher number of leaves when compared to that of weedy check (6.97). Significantly ($p<0.05$) higher stem girth was produced by plots with sawdust mulch (1.28 cm), black polyethylene mulch (1.11 cm) and weeded plot (1.06 cm) compared to weedy check (0.88 cm). At 8 WAT, significantly ($p<0.05$) higher plant heights were obtained by sawdust cover (46.1 cm), black polyethylene mulch (45.2 cm), and weeded plot (40.7 cm) compared to that of weedy check (38.0 cm). The leaf length of plots covered with

sawdust were significantly ($p<0.05$) longer than other weed management options (41.97 cm) with weedy check as the least (33.72). Significantly ($p<0.05$) bigger stem girth was produced by weeded plot (2.92), plots with sawdust mulch (1.22) and black polyethylene mulch (1.20) compared to weedy check (0.44).

Weed species	Family	Occurrence
Broadleaves		
Mimosa pudicaa Linn (sensitive plant)	Fabaceae	++
Heterotis rotundifolia (Pink lady, Spanish Shawl)	Melastomataceae	+++
Sclerocarpus africanus (African Bonebract)	Asteraceae	+++
Phyllanthus amarus (Gale of wind)	Euphorbiaceae	+++
Commelina benghalensis L (Climbing dayflower)	Commelinaceae	+
Oldenlandia corymbosa (Diamond flower)	Rubiaceae	+++
Mitracarpus villosus (Tropical girdlepod)	Rubiaceae	++
Synedrella nodiflora (Cinderella weed)	Asteraceae	+++
Peperomia pellucida (Shining bush plant)	Piperaceae	+
Amaranthus spinosus (Spiny pigweed)	Amaranthaceae	+
Solanium nigrum (Black nightshade)	Solanaceae	++
Cleome rutidosperma (Fringed spider flower)	Cleomaceae	+
Talinium triangulare (water leaf)	Portulacaceae	+
Impomoea mauritiana (Morning glory)	Convolvulaceae	++
Physalis angulata (wild tomato)	Solanaceae	++
Desmodium scorpiurus (Samoan clover)	Papilionoideae	+
Grasses		
Andropogan gayanus (Gamba grass)	Poaceae	+++
Digitaria eriantha (finger grass)	Poaceae	+++
Oxonopus compressus (Carpet grass)	Poaceae	+++
Sedges		
Cyperus deformis (Common flower)	Cyperaceae	+++
Mariscus alternifolius (umbrella sedge)	Cyperaceae	+++

Table 1: The Predominant Weed Species in the Experimental Plots in the Planting Season

Note: +=low weed occurrence ++=moderate weed occurrence +++ high weed occurrence.

Weed mgt options	Plant height (cm)	Leaf length (cm)	No.of leaves	Stem girth(cm)
2 WAT				
SD	28.78	26.52	4.36	0.47
BPM	28.57	26.02	4.42	0.47
WF	29.32	26.81	5.08	0.49
WC	30.06	27.57	5.11	0.50
F-LSD (0.05)	Ns	Ns	0.46	ns
4 WAT				
SD	41.88	37.65	7.19	1.03
BPM	41.11	37.32	7.14	0.73
WF	41.54	37.47	6.89	0.72
WC	40.86	38.25	7.17	0.75
F-LSD (0.05)	Ns	Ns	ns	ns
6 WAT				
SD	47.35	42.82	9.56	1.28
BPM	43.67	39.26	8.28	1.11
WF	41.67	37.61	9.64	1.06
WC	39.47	35.50	6.97	0.88
F-LSD (0.05)	5.64	Ns	1.84	0.22
8 WAT				

SD	46.1	41.97	10.11	1.22
BPM	45.2	40.76	9.89	1.20
WF	40.7	36.58	9.42	2.92
WC	38.0	33.72	6.81	0.77
F-LSD (0.05)	5.70	2.78	1.54	0.44

Table 2: Effect of Weed Management on Morphological Traits of Allium Cepa L. Over Months of Study in the Planting Season

WAT= Weeks after transplanting, NS= not significant, SD= sawdust, BPM= black polyethylene mulch, WF= weeding at four weeks interval, WC= weedy check.

The effect of animal droppings manure on leaf length, height of the plants, number of leaves produced as well as the stem girth at 2, 4, 6 and 8 WAT were shown in table 3. At 4 WAT, plots treated using the poultry droppings as manure produced crops with significantly ($p<0.05$) higher leaf length (41.41 cm) and higher number of leaves (7.51) than that of pig dung which recorded 33.94 cm and 6.68 respectively except in height of the plants where plots treated with pig dungs as manure produced taller crops (44.97 cm) than that of poultry which recorded (37.72 cm). At 6 WAT, plots treated with poultry droppings as manure produced taller plants (47.35 cm), leaf length (43.15 cm), number of leaves (9.39) and stem girth (2.0 cm) while the least of these parameters was consistently recorded by the plots treated with pig dung. At 8 WAT, taller plants, leaf length, number of leaves and stem girth compared to that of pig dung was recorded in poultry manure treated plots. Effect of the time of planting on the measured growth parameters at 2, 4, 6 and 8 WAT were shown on table 4. At 2WAT, plots planted within June produced significantly ($p<0.05$) taller plant (30.41 cm), longer leaves (28.04 cm) and higher number of leaves (5.46). Plots planted in the month of July recorded the least in plant height (26.94 cm), leaf length (24.81 cm), number of leaves (3.97) and highest in stem girth (0.57 cm). At 4 WAT, June planting also had taller plants that differed significantly ($p<0.05$) with longer leaves (42.05 cm) and higher number of leaves (7.92). July planting recorded the least in plant height (34.35 cm), leaf length (30.82 cm) and number of leaves (7.92) while July recorded the highest stem girth (0.98 cm). At 6 and 8 WAT, June planting equally performed better than other times of planting. Table 5 shows that the interaction of weed management options, manure type and planting time on the weight/plant, weight/plot and yield in kg/ha and ton/ha of Allium cepa L. over the duration of study differed significantly. The interaction of sawdust cover and poultry manure recorded the highest weight/plant (289.9 g), weight/plot (2435 g) and yield (16235 kg/ha) which is statistically similar with the interaction of black polyethylene mulch, poultry manure and June planting time (214.7 g, 1804 g and 12025 kg/ha) closely followed by the interaction of black polyethylene mulch, pig dung and June planting time (202.9 g, 1704 g and 11362 kg/ha) while the interaction of weedy check, pig dung and July gave the least weight per plant, weight/plot and yield (32.1 g, 269 g and 1796 kg/ha).

Manure type	Plant height(cm)	Leaf length (cm)	No. of leaves	Stem girth (cm)
2WAT				
Poultry manure	29.50	27.08	4.85	0.51
Pig dung	28.87	26.37	4.64	0.46
F-LSD (0.05)	Ns	Ns	ns	ns
4WAT				
Poultry manure	37.72	41.41	7.51	0.92
Pig dung	44.97	33.94	6.68	0.68
F-LSD (0.05)	3.10	3.01	0.47	ns
6WAT				
Poultry manure	47.35	43.15	9.39	2.00
Pig dung	38.73	34.45	7.83	0.96
F-LSD (0.05)	3.99	3.85	1.30	0.15
8WAT				
Poultry manure	47.7	43.35	10.17	1.19
Pig dung	37.3	33.17	7.94	1.87
F-LSD (0.05)	4.03	2.00	1.09	0.31

Table 3: Effect of Animal Manure Type on Morphological Traits of Allium Cepa L. Over Months of Study in the Planting Season

WAT= Weeks after transplanting, NS= not significant.

Manure type	Plant height(cm)	Leaf length (cm)	No. of leaves	Stem girth (cm)
2WAT				
June	30.41	28.04	5.46	0.44

July	26.94	24.81	3.97	0.57
August	30.20	27.74	4.81	0.44
F-LSD (0.05)	2.31	2.22	0.40	0.06
4WAT				
June	46.31	42.05	7.92	0.52
July	34.35	30.82	6.48	0.98
August	43.81	40.15	6.90	0.95
F-LSD (0.05)	3.68	3.68	0.58	0.34
6WAT				
June	51.64	45.71	11.15	1.500
July	34.88	34.98	7.46	0.88
August	39.04	35.71	7.23	0.88
F-LSD (0.05)	4.88	4.71	2.00	0.19
8WAT				
June	50.1	43.85	12.62	2.89
July	39.3	36.32	7.52	0.56
August	38.1	34.60	7.02	0.84
F-LSD (0.05)	5.70	2.40	1.33	0.31

Table 4: Effect of Planting Time on Morphological Traits of Allium Cepa L. Over the Months Planting in the Study

WAT= Weeks after transplanting, ns= not significant.

Weed mgt option	Manure type	Planting time	Wt/plt (g)	Blbwt/plot (g)	Yield (kg/ha)	Yield (ton/ha)
SD	Pig dung	June	162.4	1364	9096	9.10
BPM	Pig dung	June	202.9	1704	11362	11.36
WF	Pig dung	June	195.1	1639	10926	10.93
WC	Pig dung	June	35.1	295	1967	1.97
SD	Poultry	June	289.9	2435	16235	16.24
BPM	Poultry	June	214.7	1804	12025	12.03
WF	Poultry	June	141.1	1185	7903	7.90
WC	Poultry	June	48.0	403	2690	2.69
SD	Pig dung	July	74.1	622	4147	4.15
BPM	Pig dung	July	62.4	524	3494	3.50
WF	Pig dung	July	79.7	670	4465	4.47
WC	Pig dung	July	32.1	269	1796	1.80
SD	Poultry	July	126.3	1061	7074	7.07
BPM	Poultry	July	79.4	667	4448	4.45
WF	Poultry	July	76.4	642	4278	4.28
WC	Poultry	July	41.1	345	2300	2.30
SD	Pig dung	August	49.5	416	2774	2.77
BPM	Pig dung	August	62.5	525	3498	3.50
WF	Pig dung	August	40.3	339	2257	2.26
WC	Pig dung	August	39.3	330	2201	2.20
SD	Poultry	August	84.9	713	4756	4.76
BPM	Poultry	August	95.0	798	5322	5.32
WF	Poultry	August	61.2	514	3429	3.43
WC	Poultry	August	45.4	381	2542	2.54
F-LSD (0.05)			72.0	604.8	4031.8	4.032

Table 5: Effect of Weed Management Options, Animal Manure Type and Planting Time on Weight/Plant, Weight/Plot, Yield In Kg/Ha And Tons/Ha of Allium Cepa L. During The Experiment

MGT= management, wt/plt= weight/plant, blbwt= bulb weight, SD= sawdust, BPM= black polyethylene mulch, WF= weeding at four weekly interval, WC= weedy check.

The most dominant weed species found in this experiment were Mimosa pudica Linn, Syndrella nodiflora, Heterotis rotundifolia, Phyllanthus amarus and Oldelandia corymbosia Linn. Among the grasses the most dominant were Oxonopus compressus, Andropogan gayanus while Cyperus deformis dominated in sedges. Different weed management options had effect weeds flora populations significantly. Weedy check treatment produced significantly ($p<0.05$) more number of weeds than other weed managements options employed. The least weed population was obtained with plots covered with black polyethylene followed closely by sawdust mulch, this might be due to light interception on the weed seeds which reduced photosynthesis thereby inhibiting weed emergence and subsequent growth as reported by [15]. The dry weight of weeds as observed to be higher in weedy check plots agreeing with, who noted that the weeds density and dry weight were higher in weedy check when compared with other treatments [16]. During the growth stages, black polyethylene cover recorded maximum weed control efficiency. Significantly ($p < 0.05$) black polyethylene cover had higher weed control efficiency in this study while weedy check consistently recorded the least efficiency, this may be as a result of the mulch material ability to limit growth of weeds. This agrees with the report of who said that weed control efficiency of black mulch were higher significantly than other studied methods of weed control [17].

Weed management options affected vegetative parameters of the Allium cepa L significantly. The plots treated with sawdust cover produced taller plants compared with that of weedy check. The leaf length of plots covered with sawdust were longer than other weed management options with weedy check as the least. Stem girth were bigger with sawdust mulch and black polyethylene mulch compared to weedy check. Sawdust proved to give high yield at the course of the study. This might be due its ability to moderate the soil temperature during the experimentation and ensure moderate soil moisture while black mulch warms up soil faster and increases the soil temperature as reported by [18]. The sawdust cover recorded higher yield of 7347 kg/ha which was statistically similar to that of black polyethylene cover (6692 kg/ha) and weeding at 4 weekly intervals (5543 kg/ha) while the least mulching method yield was observed in the weedy check (2249 kg/ha). This result agrees with [15]. that the yield increase due to mulching may be related to increased beneficial micro-organisms population, reduced weed growth and increased fertility and moisture due to the treatment.

The result of this experiment shows significant difference in the plot treated with droppings of poultry and pigs. Poultry droppings as manure source produced higher yield of 6084 kg/ha when compared to pig dung 4832 kg/ha. This might be because poultry is rich in plant nutrient elements such as nitrogen, potassium and phosphorous and also reported that red creoles onion increased in leaf length, and other vegetative traits due poultry droppings addition that caused consequent nutrient elements addition [16,19]. This study agrees with the conclusions of that observed poultry droppings addition as manure source increased all the growth and yield parameter measured where Kalmegh plant was used for the experiment [19]. Also observed that seed of red cedar growth on poultry droppings enriched soil performed better than those plants treated with droppings of pigs and cows [7].

The interaction effect of the three factors (weed management option, manure type and time of planting) differed, higher weight/plant, weight/plot and yield of (289.9 g, 2435 g, and 16235 kg/ha) was obtained with the interaction between sawdust cover, poultry manure and June planting time which is statistically similar to the interaction of Black polyethylene cover, poultry manure and June planting time (214.7g/plant, 1804 g/plot and 12025 kg/ha) while the least weight / plant, weight/plot and total yield of (32.1 g, 269 g and 1796 kg/ha) was noted with the interaction of weedy check, pig dung and July planting time. The interaction of sawdust cover, poultry manure recorded highest yield in each of the planting time except August planting time where black polyethylene cover and poultry recorded highest yield while weedy check and pig dung consistently recorded the least yield in all the planting times.

Conclusion and Recommendations

The results of the experiment confirmed using sawdust as mulch material is the best form the options studied for onion production given its ability to improve the vegetative growth and the measured yield traits of Allium cepa L in the area. From the results, poultry droppings as a source of manure significantly produced taller plant heights, longer leaf length, larger stem girth, and higher yield compared to that of pigs and therefore it is recommended. Also, from the result, June planting time is ascertained to be the best planting time for onion production in Wolaita derived tropical of southern Ethiopia compared to others and is thereby recommended for maximum yield.

Acknowledgment

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Conflict of Interest

The authors have declared that that there are no comflict of interests.

Authors Contribution

AKM, contributed to the project idea, design and execution of the study. FTH, conducted the field work and data analyses. YSA, supervised the experiment and wrote the manuscript.

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